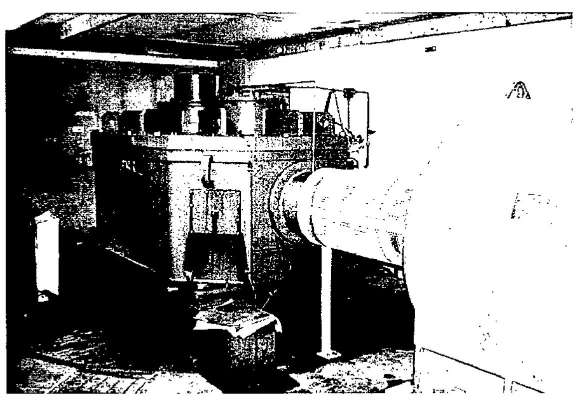
U.S. Army Corps
of Engineers
Walla Walla District

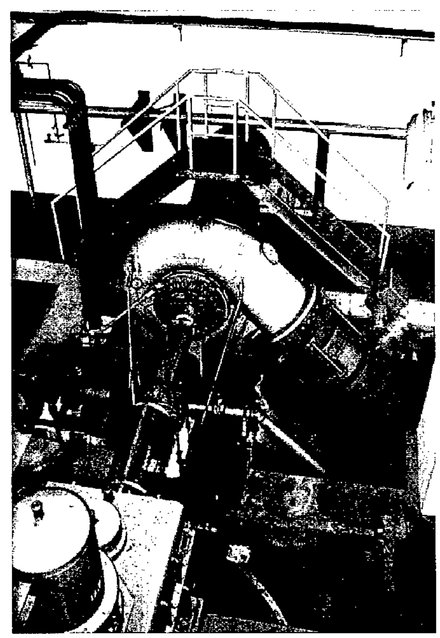
LOWER SNAKE RIVER
LITTLE GOOSE AND LOWER GRANITE LOCKS AND DAMS

Adult Fishway Systems
Emergency Auxiliary Water Supply
Phase II – Technical Report

Final Report

September 2000





Prepared by:

Sverdrup
A Jacobs Company

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Rolf Wielick

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Sverdrup
600 - 108th Avenue NE
Suite 700
Bellevue, WA 98004

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The National Marine Fisheries Service (NMFS), Endangered Species Act, Biological Opinion issued March 2, 1995, required the US Army Corps of Engineers to develop an emergency auxiliary water supply (EAWS) system for all adult fishways where determined to be necessary in coordination with NMFS A reconnaissance level technical report (Lower Snake River, Adult Ladder Systems, Emergency Auxiliary Water Supply (Phase I - Technical Report) prepared in 1995, identified several alternative methods of providing emergency auxiliary water supply for each of the adult fishway systems at each of the four lower Snake River locks and dams to address the Biological Opinion requirement. This Emergency Auxiliary Water Supply, Phase II - Technical Report continues to evaluate the Phase I report alternatives for the Little Goose and Lower Granite Locks and Dams at a greater level of detail.

The objectives of this Phase II report are to evaluate, in greater detail, the alternatives previously identified in Phase I report and recommend a selected alternative for providing EAW supplies for each of the adult fishway systems at Little Goose and Lower Granite. This Phase Ii report identifies a construction cost estimate, including engineering and design, supervision and administrative costs and presents a proposed schedule for completing the design and construction of the recommended alternatives for each dam.

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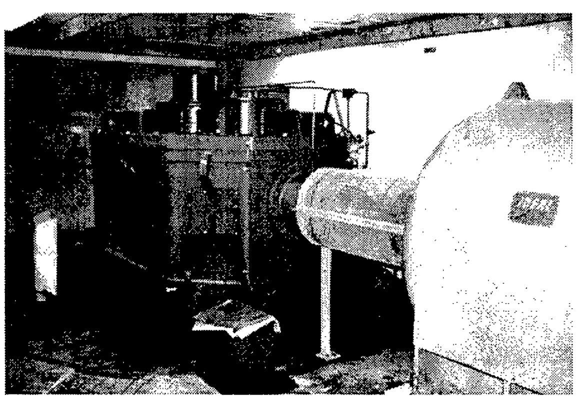

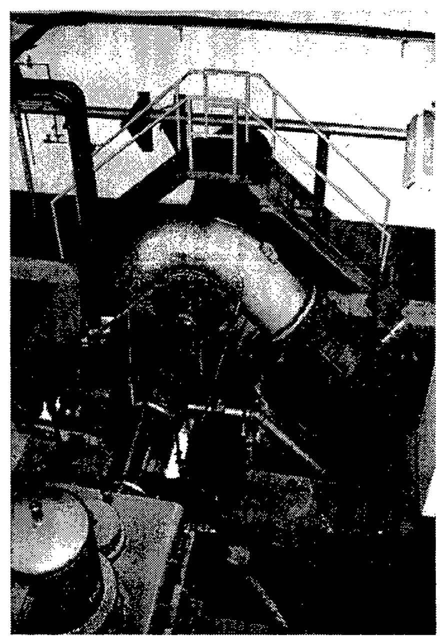

Prepared by:

JE Sverdrup
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EXECUTIVE SUMMARY

General:

The National Marine Fisheries Service (NMFS), Endangered Species Act - Section 7 Consultation, Biological Opinion issued March 2, 1995, requires the U.S. Army Corps of Engineers to develop an emergency auxiliary water supply (EAWS) system for all adult fishways where determined to be necessary in coordination with NMFS. A reconnaissance level technical report [Lower Snake River, Adult Ladder Systems, Emergency Auxiliary Water Supply (Phase I - Technical Report)] prepared in 1995 identified several alternative methods of providing emergency auxiliary water supply for each of the adult fishway systems at each of the four lower Snake River locks and dams to address the Biological Opinion requirement. This Emergency Auxiliary Water Supply, Phase II - Technical Report (Phase II - Technical Report) continues to evaluate the Phase I report alternatives for the Little Goose and Lower Granite Locks and Dams (Little Goose and Lower Granite) at a greater level of detail.

Adult fishway auxiliary water supply (AWS) systems provide fish attraction water flows to help migrating adult salmonids to find fish ladder entrances and to proceed up the fishways with minimum delay. The focus of this Phase II - Technical Report is the reliability of these auxiliary water supply systems at two of the four lower Snake River locks and dams.

The objectives of this Phase II report are to evaluate, in greater detail, the alternatives previously identified in the Phase I report and recommend a selected alternative for providing emergency auxiliary water supplies for each of the adult fishway systems at Little Goose and Lower Granite. This Phase II report identifies a construction cost estimate including engineering and design, supervision and administrative costs and presents a proposed schedule for completing the design and construction of the recommended alternatives for each dam.

Little Goose Lock and Dam:

An evaluation of the reliability of the existing AWS system and its ability to provide an emergency auxiliary water supply in the event of a failure in the AWS system determined the following:

System Reliability:

The existing auxiliary water system at Little Goose has generally been a reliable system over the years. The turbine/gearbox/pump system appears to have considerable remaining service life. The electric wicket gate operators are susceptible to a single mode failure rendering them without electrical actuation capability for an extended period of time.

EAWS Status:

All three AWS pumps are required to meet Fish Passage Plan (FPP) criteria, although conformance to the criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and low transport velocities at various locations in the fishway channel. Because all three pumps are required, there is no emergency spare capacity (emergency auxiliary water supply) at the project in the event of a single-pump failure. Thus, the EAWS requirement for a minimum of a one-pump equivalent spare capacity is not being met at this project.

Little Goose Alternatives:

A total of five alternatives were reviewed in this Phase II report for Little Goose. Four of these alternatives would provide the project with the required EAWS one-pump spare capacity (Alternatives 1, 2, 3, and 5) while the remaining alternative (Alternative 4) would increase the reliability of the existing AWS system through a program of enhanced maintenance, an increased spare parts inventory, and by reliability upgrades. A brief description of these alternatives follows:

Alternative 1:

In Alternative 1, a new forebay intake routes flow by gravity via a new 90-inch steel pipe constructed through the South Non-Overflow Dam to the existing AWS pump discharge chamber at the Erection Bay, providing 850 cfs of EAWS flow to the AWS system. The forebay intake is comprised of two dual-flow traveling screens designed to exclude fish and debris. Flow is controlled by a single 72-inch in-line sleeve valve located near the pump chamber.

Alternative 2:

In Alternative 2, a new emergency pump station is constructed off the tailrace deck above the draft tube discharge at Turbine Unit No. 2, providing 850 cfs of EAWS flow to the AWS system. The water from the pump station is discharged through an existing conduit to the north to Diffuser No. 12 and to the south to the main pump discharge chamber to serve the rest of the auxiliary water system.

Alternative 3:

In Alternative 3, the existing hydro-turbine AWS pump system is replaced with three large capacity electric motor-driven pumps. Two of the three pumps would provide the normal AWS water. The third new pump would become the spare pump in the event of failure of one of the other two pumps, thus providing the EAWS flow for the system.

Alternative 4:

In Alternative 4, the spare parts inventory is increased for the existing AWS system. Oil heaters are added to the speed reducers for the pumps and an automatic transfer switch is added to the wicket gate operator circuit. These equipment modifications are intended to improve the reliability of the system. Note that Alternative 4 increases reliability but does not provide spare EAWS capacity in the event of a long-term outage of one of the AWS pumps.

Alternative 5:

In Alternative 5, a new emergency pumped supply is constructed utilizing the existing AWS pump intake, providing 850 cfs of EAWS flow to the AWS system. Three new pumps are installed in a new pump well drawing water through openings created in the roof of the intake. Water is pumped to Diffusers No. 1 and 2, which are isolated from the rest of the AWS system during operation of the EAWS system.

Cost Estimates:

The estimated construction costs for the Little Goose alternatives are as follows:

Little Goose EAWS Alternative	**Construction Cost [1]**	**Total Cost [2]**	**Comments**
Alternative 1[3]	$4,776,227	**$6,447,906**	
Alternative 2[3]	$8,701,465	**$11,746,978**	
Alternative 3	$10,878,471	**$14,685,936**	
Alternative 4	$50,576	**$68,278**	Does not meet EAWS criteria
Alternative 5[3]	$4,935,628	**$6,663,098**	

(1) Includes contractor mob/demob,OH and profit, and a 25% construction contingency

(2) Includes engineering and planning, and construction management

(3) Alternative 4 costs not included in costs for these alternatives (not applicable to Alternative 3)

Little Goose EAWS Alternative Cost Summary

Conclusions and Recommendations:

Alternatives 1 and 5 compare very favorably to each other. Alternative 3, despite being good in most regards, was eliminated because of excessive construction cost compared to the other comparable systems. Alternative 2, because of the combined need for pumps and fish screening equipment (both costly components), is considerably more expensive than either Alternatives 1 or 5.

Either Alternative 1 or 5 appear to be the most appropriate EAWS designs for Little Goose. However, because of the inherently more simplistic system represented in Alternative 5, this is selected as the recommended system.

Alternative 4, which increases the reliability of the existing AWS system, is recommended to supplement Alternative 5 to add a measure of increased reliability.

Design and Construction Schedule:

The total design and construction duration is estimated to be from the start of design on June 1, 2001 to completion of operational tests in late March, 2003.

Lower Granite Lock and Dam:

An evaluation of the reliability of the existing AWS system and its ability to provide an emergency auxiliary water supply in the event of a failure in the AWS system determined the following:

System Reliability:

Like the system at Little Goose, the existing auxiliary water system at Lower Granite has generally been a reliable system over the years. The electric motor-gear box-pump system appears to have considerable remaining service life based on the performance history of comparable systems.

AWS Pump 1 (which has not been operated successfully since 1995) is not currently operable and consequently there is no spare capacity until it is repaired (see EAWS Status discussion below).

The reliability of electrical power supply to the motors is not acceptable. This is due to the lack of redundancy of the power supply to the motors and the potential for a single-mode system failure caused by an electrical fault in the electrical equipment enclosure.

EAWS Status:

Based on the operational history at the Lower Granite, only two of the existing three pumps are required to meet FPP criteria, although conformance to these criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and low transport velocities at various locations in the fishway channel. Thus, when all three pumps are in operating condition, there is a one-pump spare capacity at the project, meeting the spare capacity requirement listed in the assessment criteria.

Lower Granite Alternatives:

Two alternatives were reviewed in this Phase II report for Lower Granite. Because the project currently has spare EAWS system capacity in the third (unused) pump, no EAWS alternatives were evaluated. Rather, efforts concentrated on upgrading the equipment to improve reliability and increasing spare parts inventories (Alternative 1) or simply increasing the spare parts inventory (Alternative 2). AWS Pump 1 is inspected, refurbished as needed and thoroughly tested before either alternative is implemented. This work is funded separately as part of normal project operations. A brief description of these alternatives follows:

Alternative 1:

In Alternative 1, oil heaters are recommended for the speed reducers to improve operability and increase reliability and the Formsprag anti-backspin device on Pump 1 is repaired. The existing Philadelphia speed reducer on Pump 1 is replaced by the spare Falk unit to provide consistent equipment in the pump house. On the electrical side, an automatic transfer switch is added to the reconfigured pump power supply system and the motor control centers for the pumps are physically separated. In addition to these equipment upgrades, an expanded inventory of spare parts is proposed.

Alternative 2:

In Alternative 2, none of the equipment upgrades are made. Only the spare parts inventory is provided.

Cost Estimates:

The estimated construction costs for the Lower Granite alternatives are as follows:

Lower Granite EAWS Alternative	Construction Cost (1)	Total Cost (2)	Comments
Alternative 1	$206,321	**$278,534**	Spare Parts Cost: $144,130
Alternative 2	(NA)	(NA)	Spare Parts Cost: $144,130

(1) Includes contractor mob/demob,OH and profit, and a 25% construction contingency

(2) Includes engineering and planning, and construction management

Lower Granite EAWS Alternative Cost Summary

Conclusions and Recommendations:

Alternatives 1 and 2 are different only in that Alternative 2 does not include the equipment reliability upgrades proposed for the pumping equipment. Because of the modest investment represented by the equipment reliability upgrades proposed for Alternative 1 and the significant increase in reliability and operability they represent, Alternative 1 should be selected. The benefit of an enhanced parts inventory will only increase the reliability and decrease the maintenance pressures resulting from failure of critical parts. Thus, Alternative 1 is the recommended alternative at Lower Granite.

Design and Construction Schedule:

All of the constructed features associated with Alternative 1 must be completed during the maintenance window for the fish ladders in January and February.

SECTION 1 - INTRODUCTION

1.1 GENERAL

The National Marine Fisheries Service (NMFS), Endangered Species Act - Section 7 Consultation, Biological Opinion issued March 2, 1995, requires the U.S. Army Corps of Engineers to develop an emergency auxiliary water supply system for all adult fishways where determined to be necessary in coordination with NMFS. A reconnaissance level technical report [Lower Snake River, Adult Ladder Systems, Emergency Auxiliary Water Supply (Phase I - Technical Report)] [1] prepared in 1995 identified several alternative methods of providing emergency auxiliary water supply for each of the adult fishway systems at each of the four lower Snake River locks and dams to address the Biological Opinion requirement. This Emergency Auxiliary Water Supply, Phase II - Technical Report (Phase II - Technical Report) continues to evaluate the Phase I report alternatives for the Little Goose and Lower Granite Locks and Dams (Little Goose and Lower Granite) at a greater level of detail.

1.2 AUTHORIZATION

This study is an element of the Columbia River Fish Mitigation Program (CRFMP) and is being conducted under the Rivers and Harbors Act of 1945, Public Law 79-14, dated March 2, 1945.

1.3 PURPOSE

Adult fishway auxiliary water supply systems provide fish attraction water flows to help migrating adult salmonids to find fish ladder entrances and to proceed up the fishways with minimum delay. The focus of this Phase II - Technical Report is the reliability of these auxiliary water supply systems at two of the four lower Snake River locks and dams.

1.4 SCOPE

The objectives of this Phase II report are to evaluate, in greater detail, the alternatives previously identified in the Phase I report and recommend a selected alternative for providing emergency auxiliary water supplies for each of the adult fishway systems at Little Goose and Lower Granite. This Phase II report identifies a construction cost estimate including engineering and design (E&D) and supervision and administrative (S&A) costs and presents a proposed schedule for completing the design and construction of the recommended alternatives for each dam.

1.5 PRIOR STUDIES

Several studies and reports already completed as well as new investigations were used to help prepare this Phase II - Technical Report. The following is a partial listing of prior studies and reports:

- *Lower Snake River, Adult Ladder Systems, Emergency Auxiliary Water Supply*, November 1, 1995, (Phase I - Technical Report) [1]
- *Lower Snake River, Ice Harbor and Lower Monumental Locks and Dams, Adult Fishway Systems Emergency Auxiliary Water Supply*, August 1999, (Phase II - Technical Report) [2]
- *Hydraulic Evaluation of Adult Fish Passage Facilities at Lower Granite Dam*, July 1995 [3]
- *Columbia River Salmon Mitigation Analysis System Configuration Study Phase I*, April 1994 [4]
- *Hydraulic Evaluation of Adult Fish Passage Facilities at Little Goose, Lower Monumental, and McNary (South Shore) Dams*, November 1988. [5]
- Value Engineering Study Ice Harbor and Lower Monumental Dams EAWS, May 2000. [6]

Other references utilized in this report are listed in Appendix E.

1.6 SUMMARY OF PHASE I – TECHNICAL REPORT

The Phase I report discussed four basic types of alternatives for improving the reliability of the existing auxiliary water supply and for providing additional emergency auxiliary water as follows:

- Modify the existing auxiliary water pump system to improve reliability.
- Develop new sources of gravity water supply from the forebay.
- Develop new sources of pumped water supply from the tailrace.
- No action.

Specific alternatives evaluated for Little Goose and Lower Granite in the Phase I report were as follows:

Little Goose:

Alternative 1 - Gravity feed through non-overflow section
Alternative 2 - Spiral case tap to pump discharge chamber
Alternative 3 - Add two pumps north of north fishway entrance
Alternative 4 - Enhanced preventive maintenance program
Alternative 5 - No action

The recommended alternative for Little Goose was Alternative 4 - Enhanced preventive maintenance program.

Lower Granite:

Alternative 1 - Increase the reliability of the electrical supply and enhanced preventive maintenance program
Alternative 2 - Gravity feed supply through south non-overflow section
Alternative 3 - Enhanced preventive maintenance program
Alternative 4 - No action

The recommended alternative for Lower Granite was Alternative 1 - Increase the reliability of the electrical supply and enhanced preventive maintenance program.

SECTION 2 - TECHNICAL CRITERIA AND PROJECT DATA

2.1 PERTINENT PROJECT DATA

2.1.1 Little Goose Lock and Dam

General:

River Location (from confluence with Columbia River) .... 70.3 miles
Number of Generating Units 6
Output Capacity (Nameplate Rating) .... 810,000 kW
Number of Spillbays 8
Intake Diversion Screen Type .... ESBS
Number of Adult Fish Ladders 1

Dimensions:

Powerhouse Overall Length .... 656 ft
Unit Width (Units 1 to 5) .... 90 ft
Unit Width (Unit 6) .... 96 ft
Erection Bay Width .... 110 ft
Spillway Overall Length .... 512 ft
Spillbay Center-to-Center Spacing .... 64 ft
Spillbay Gate Width .... 50 ft
Spillbay Gate Height (above spillway crest) .... 59 ft

Elevations: (referenced to mean sea level)

Maximum Pool (Design Flood Condition) .... 646.5 ft
Maximum Operating Pool .... 638.0 ft
Minimum Operating Pool .... 633.0 ft
Top of Tainter Gates (Closed) .... 640.0 ft
Spillway Crest .... 581.0 ft
Maximum Flood Tailwater (850,000 cfs) .... 564.4 ft
Max. Normal Tailwater .... 540.0 ft
Min. Normal Tailwater (M.O.P. at Lower Monumental) .... 537.0 ft
Intake Deck .... 651.0 ft

Upstream Migrants Fish Ladder:

Number of fish ladders 1
Slope .... 1V on 10H
Ladder clear width .... 20 ft
Design capacity .... 75 cfs

Exit channel:
Location ....Between weir 637 and pool in non-overflow section
Top of trashrack .... 632.0 ft
Invert .... 627.0 ft
Width .... 6 ft

Pumps for fishway system attraction water:
Number 3
Rated Capacity (total at 4 ft. of pumping head) ....2,550 cfs

2.1.2 Lower Granite Lock and Dam

General:

River Location (from confluence with Columbia River) .... 107.5 miles
Number of Generating Units 6
Output Capacity (Nameplate Rating) .... 810,000 kW
Number of Spillbays 8
Intake Diversion Screen Type ....ESBS

Dimensions:

Powerhouse Overall Length .... 656 ft
Unit Width (Units 1 to 5) .... 90 ft
Unit Width (Unit 6) .... 96 ft
Erection Bay Width .... 110 ft
Spillway Overall Length .... 512 ft
Spillbay Center-to-Center Spacing .... 64 ft
Spillbay Gate Width .... 50 ft
Spillbay Gate Height (above spillway crest) .... 59 ft

Elevations: (referenced to mean sea level)

Maximum Pool (Design Flood Condition) .... 746.5 ft
Maximum Operating Pool .... 738.0 ft
Minimum Operating Pool .... 733.0 ft
Minimum Flood Control Pool .... 724.0 ft
Top of Tainter Gates (Closed) .... 740.0 ft
Spillway Crest .... 681.0 ft
Maximum Flood Tailwater (850,000 cfs) .... 662.9 ft
Normal Maximum Tailwater (340,000 cfs) .... 645.5 ft
Tailwater at Maximum Powerhouse Flow (130,000 cfs) .... 639.2 ft
Normal Tailwater .... 638.0 ft
Minimum Tailwater (zero flow) .... 633.0 ft
Intake Deck .... 751.0 ft

Upstream Migrants Fish Ladder:

Number of fish ladders 1
Slope:
Weir 634 - Weir 727 .... 1V on 10H
Weir 728 - Weir 737 .... 1V on 32H
Ladder clear width .... 20 ft
Design capacity ....75 cfs

Exit channel:
Location ....Between weir 737 and pool in non-overflow section
Top of trashrack.. 732.0 ft
Invert.. 727.0 ft
Width .... 6 ft

Alternate exit channel (pool El. below 727 ft.):
Exit pipe to reservoir ....18-inch-diameter full plastic pipe down to El. 718 ft. and a half-round plastic pipe down to El. 710 ft.

Pumps for fishway system attraction water:
Number.. 3
Rated Capacity (total at 4 ft. of pumping head)..3,150 cfs

2.2 EXISTING SYSTEM ASSESSMENT METHODOLOGY

2.2.1 Hydraulic and Adult Fish Passage

The hydraulic and fish passage performance of the existing adult fish passage and auxiliary water systems was evaluated through review of existing drawings and documents. These included the *Fish Passage Plan* (for Lower Granite and Little Goose), February 2000 [7][8]; *Little Goose Lock and Dam Operations Manual, Fishway and Equipment (Chapter 5)* [9]; *Hydraulic Evaluation of Adult Fish Passage Facilities at Little Goose, Lower Monumental, and McNary (South Shore) Dams*, November 1988 [5]; *Lower Granite Lock and Dam, Fishway Operation Guide* [11]; *and Hydraulic Evaluation of Adult Fish Passage Facilities at Lower Granite Dam*, July 1995 [3]. In addition, during the project kickoff site visit on February 28 and 29, 2000, hydraulic performance characteristics of the adult fishways at Little Goose and Lower Granite Dams were also discussed with project personnel, primarily Ray Eakin (USACE, Little Goose) and Dick Hammer (USACE, Lower Granite). Notes from these meetings are found in Appendix B. A second inspection trip was made to both plants on May 16 and 17, 2000 to obtain additional mechanical and electrical data. Notes from these meetings are also found in Appendix B.

2.2.2 Mechanical and Electrical Systems

The performance of the mechanical and electrical systems associated with the auxiliary water systems at Little Goose and Lower Granite were evaluated through a combination of a review of existing drawings and documents including operations and maintenance manuals and reports, and original equipment vendor information. The projects were visited on February 28 and 29, 2000 during the initial site visit, making it possible to interview project maintenance staff regarding the operations and maintenance aspects of the equipment. A subsequent site visit to both Little Goose and Lower Granite was conducted on May 16 and 17, 2000 to further document the condition and status of the AWS systems.

During the initial site visit, the pumps and their auxiliaries were observed in operation to the extent possible noting that the pumps at Lower Granite (including Pump 1 which has not operated in over 5 years) were not operating and therefore could not be observed in that manner. On the subsequent visit, Pumps 2 and 3 at Lower Granite were operating, although Pump 1 was again not available for observation. The pumps were observed for vibrations, noise, operating temperatures and pressures. These observations formed a basis for evaluation of the existing installations. Detailed inspection of turbine or pump water passages was not possible.

Plant personnel were also interviewed for overall operation of the auxiliary water supply system. Of prime importance for the mechanical evaluation was the maintenance history of the pumping systems. Plant operations and maintenance records were inspected at the plants. Copies of pertinent materials were obtained. Some of the project data were not available for review and as such, were not utilized in this report.

2.3 ASSESSMENT AND DESIGN CRITERIA

Providing spare water supply capacity increases system reliability by providing emergency water supply for use during partial failures. It also increases the opportunity for practicing preventive maintenance on idle equipment without requiring system operation outside the criteria of the Fish Passage Plan (FPP), U.S. Army Corps of Engineers, (February 2000) [7][8], during the maintenance activity. Spare water supplies can be used periodically so that actual operating time on equipment can be reduced, thus increasing useful operating life. The following general criteria were used in Phase I and Phase II reports for assessing existing systems, sizing gravity supply systems, sizing additional pumping alternatives, and providing improved reliability:

2.3.1 Mechanical

The mechanical pumping system's reliability should provide approximately one pump equivalent of additional "emergency" flow capacity above the flow required to supply the current AWS system needs. In the event of a single pump outage, the system should be able to stay within the FPP criteria, or perhaps more correctly stated, should meet the FPP criteria to at least the same degree of conformance as the current system. It is assumed that repairs would be made efficiently, and that systems would be returned to operating condition expeditiously. Performing expeditious repairs and efficient, cost effective routine maintenance, requires that certain mission essential support equipment and staff be available on short notice. As such, sufficient spare parts should be on hand to effect rapid repairs during the adult migration season. In general, repairs should be possible within 24 hours except for failures of major equipment such as motors, turbines, pumps or speed reducers. Also, adequate facilities should be provided to perform rapid repairs. e.g., cranes, hoists, isolating bulkheads and gates. Changes in pump (or other water supply) configuration should be accomplished in less than 24 hours. This would include rotating a spare "emergency" AWS pump into operation and a failed pump out of operation or an "emergency" water supply such as a standby pump station into operation to replace a failed pump.

In assessing the existing system components, it is assumed that the present condition of existing systems must be suitable for continued service for a 25-year period, assuming continued good maintenance practices. New system designs should similarly provide for a minimum of 25 years of service with appropriate maintenance.

Mechanical system designs for new installations shall be in conformance with the applicable industry codes and standards including:

- American Institute of Steel Construction (AISC)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Welding Society (AWS)
- American Water Works Association (AWWA)
- American Society of Mechanical Engineers (ASME)
- Hydraulic Institute Pump Standards (ANSI/HI)
- American Gear Manufacturers Association (AGMA)

2.3.2 Electrical

Ideally, the electrical reliability should provide for 100 percent backup in the event of electrical outage due to bus, switchgear, or transformer failures. For some features (*e.g.,* station service transformers, main feeders, and switchgear), this redundancy was provided in the original design. Where historical data shows that failures have been rare or have never occurred in key components, changes in the electrical arrangement (required for full 100 percent backup of those components) are not economically justified. However, where aging equipment justifies it or where current technology has improved, changes in equipment to increase system reliability are proposed. Also, a logical division of electrical service is proposed to provide for the FPP required water supply during the repair period following any motor controller electrical failure.

Electrical system designs for new installations shall be in conformance with the applicable industry codes and standards including:

- National Electric Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Underwriters Laboratory (UL)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Association of Edison Illuminating Companies ((AEIC)
- Insulated Cable Engineers Association (ICEA)
- National Fire Protection Association (NFPA)

2.3.3 Adult Fish Passage and General Hydraulics

2.3.3.1 History

In 1969 from July through September, Burton Carnegie and Charles Junge conducted operational fishway studies at The Dalles Lock and Dam. They found that the largest percentage of the adult salmonids passed through the entrance with a weir depth of 8.0 ft. in the north fishway. When the weir depth was 4, 6, and 7.5 ft., the percentage of adult salmonids that passed through the entrance over the weir decreased. Additional experimentation was initiated at Ice Harbor in September 1969 to test the advisability of increasing the auxiliary water supply used to obtain a head of at least 1 ft. and a weir depth of 8 ft. The results from that experiment indicated that the preferred depth for both ladder entrances was also 8 ft. Studies in the 1970's further indicated that salmonids prefer a depth of 8 ft. or greater in the fishways.

2.3.3.2 Current Criteria

In 1980, the criteria for the Snake River locks and dams were changed to the new criteria resulting from the studies noted in paragraph 2.3.3.1. The new criteria were included in the FPP (a document that describes year-round project operations necessary to protect and enhance salmon species as well as other anadromous fish species). The FPP is revised periodically to incorporate changes to project operation and maintenance (O&M) as a result of new facilities or changes in operational procedures developed through coordination with other agencies. Fish biologists believe that dam passage delays for migrating salmon would be reduced if fishways are operated within the new optimum criteria in the FPP. The 2000 FPP criteria for the operation of adult fishways for Little Goose and Lower Granite are listed below:

Little Goose

- South Shore Entrances (SSE-1 and 2) - Both gates will be operated. A weir depth will be maintained at 8 ft. or greater below tailwater elevation. Elevation of top of gates when on sill = 529.0 ft.

- North Powerhouse Entrances (NPE-1 and 2) - Both gates will be operated. A weir depth will be maintained at 7 ft. or greater below tailwater elevation. When the tailwater elevation is less than 539.0 ft, then the weir will be on sill (elevation of the top of the weir gate on sill = 532.0 ft).
- North Shore Entrances (NSE-1 and 2) - Operate both downstream gates. A weir depth will be maintained at 6 ft. or greater below tailwater elevation. Elevation of the top of the weir gate on sill = 529.0 ft.
- Powerhouse Collection System - Operate 4 floating orifices (numbers 1, 4, 6, and 10).
- Head on all Fishway Entrances - The head differential across all fishway entrances will be between 1 ft. and 2 ft.
- Transportation Velocity - The velocity of flow in all fish conduits will be between 1.5 fps and 4 fps.

Lower Granite

- South Shore Entrances (SSE-1 and 2) - Both gates will be operated. A weir depth will be maintained at 8 ft. or greater below tailwater elevation. Elevation of top of gates when on sill = 625 ft.
- North Powerhouse Entrances (NPE-1 and 2) - Both gates will be operated. A weir depth will be maintained at 8 ft or greater below tailwater elevation. When the tailwater elevation is less than 636.0 ft, then the weir will be on sill (elevation of the top of the weir gate on sill = 628.0 ft).
- North Shore Entrances (NSE-1 and 2) - Operate both downstream gates. A weir depth will be maintained at 7 ft. or greater below tailwater elevation. Elevation of top of gates when on sill = 625 ft.
- Powerhouse Collection System - Operate 4 floating orifices (numbers 1, 4, 7, and 10).
- Head on all Fishway Entrances - The head differential across all fishway entrances will be between 1 and 2 ft.
- Transportation Velocity - The velocity of flow in all fish conduits will be between 1.5 fps and 4 fps.

2.3.3.3 Criteria for New Design

For the design of new fish-bearing water conduits and appurtenances in the adult fishways, criteria are established on a site-specific basis in the *Fish Passage Plan*, USACE (see above). Criteria stated in the *Fish Passage Plan* reflect optimum conditions established by general fish passage research and site-specific limitations. The *Fisheries Handbook of Engineering Requirements and Biological Criteria, USACE, North Pacific Division*, Milo C. Bell; and *Fishway Design Guidelines For Pacific Salmon*, K. Bates are appropriate general references that further address design issues and criteria. The design of juvenile fish facilities shall conform to the latest National Marine Fisheries Service *Juvenile Fish Screening Criteria.*

The combined influences of entrance widths, submergence of weir gates, and required head differentials (which generate flow velocity at the fishway entrances) establish flow rates that must be supplied to the fishways. The auxiliary water supply is the primary source of this flow. Local flow rates through the fishway in conjunction with fishway cross-section also establish local transport velocities. In addition, the influence of diffusers that locally add flow to the fishway and loss of flow at the various fishway entrances change flow rates and transport velocities along the fishway.

It is desirable that the quality (including temperature) of the water supplied by the AWS and EAWS systems match the quality of the water passing through the ladders. The quality of the water in the ladders and in the AWS and EAWS systems can be influenced by reservoir stratification and the elevations of flow withdrawal from the reservoir. Fortunately, vertical stratifications, depending on season, are weak to non-existent at both Lower Granite and Little Goose. As a consequence, variations in water quality as a function of elevation of withdrawal are small. Currently, AWS water is primarily drawn from the tailraces in zones that are supplied by the deep power releases. The water quality match achieved through use of the proposed EAWS systems will be comparable to, or better than, the water quality matches obtained with these current systems.

For the design of new non-fish-bearing water conduits and appurtenances, industry codes and standards apply including those established by the American Water Works Association (AWWA) as well as design guidelines presented in the *Hydraulic Institute Pump Intake Design Standards (ANSI/HI), Hydraulic Design Criteria*, U.S. Army Corps of Engineers; *Design of Small Dams*, U.S. Bureau of Reclamation; *Hydraulic Design of Stilling Basins and Energy Dissipators*, U.S. Bureau of Reclamation, and *Internal Flow Systems*, D. S. Miller.

2.3.4 Structural

No assessment of the structural components of the existing auxiliary water system were performed in conjunction with this Phase II report since the reliability and adequacy of the existing structural components in the system were not issues for review. Since many of the alternatives reviewed in the Phase I and Phase II reports involve development of new structural systems, such as new pump stations, penetrations through the dam, and new loading conditions on existing dam structures, structural criteria are presented in this section to address these designs. Therefore, structural design for new components associated with the auxiliary water systems at Little Goose and Lower Granite shall be in accordance with the following:

- *Strength Design for Reinforced-Concrete Hydraulic Structures* - U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-2104, June 30, 1992.
- *Design of Hydraulic Steel Structures* - U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-2105, March 31, 1993.

- *Gravity Dam Design* - U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-2200, June 30, 1995 (Original Publication September 25, 1958).
- *Planning and Design of Hydroelectric Power Plant Structures* – Engineer Manual EM-1110-2-3001, April 30, 1995.
- *General Principles of Pumping Station Design and Layout* – Engineer Manual EM 1110-2-3102, February 28, 1995.
- *Mechanical and Electrical Design of Pumping Stations* – Engineer Manual EM-1110-2-3105, November 30, 1995.
- *Seismic Design for Buildings* - Departments of the Army, Navy, and Air Force, Army Technical Manual Designation TM 5-809-10, October 20, 1992.
- *American Concrete Institute (ACI)*
- *American Institute of Steel Construction (AISC)*
- *American National Standards Institute (ANSI)*
- *American Welding Society (AWS)*
- *American Society for Testing and Materials (ASTM)*
- *American Water Works Association (AWWA)*
- *Military Specifications (MS)*
- *Structural Steel Painting Council (SSPC)*
- *Uniform Building Code (UBC)*
- *FEMA 302, NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*

2.4 LIST OF ABBREVIATIONS AND ACRONYMS

The following is a listing of commonly applied abbreviations and acronyms. Abbreviations and acronyms associated with design codes and standards have not been included.

Abbreviation / Acronym	**Description**
AWS	Auxiliary water supply
cfs	Cubic feet per second
EAWS	Emergency auxiliary water supply
El.	Elevation
ESBS	Extended length submersible bar screens
FPP	Fish Passage Plan
fps	Feet per second
ft	feet
gpm	Gallons per minute
H	horizontal
kW	kilowatt
msl	Mean Sea Level
NPE	North Powerhouse (Ladder) Entrance
NSE	North Shore (Ladder) Entrance
O&M	Operations and maintenance

Abbreviation / Acronym	Description
rpm	Revolutions per minute
S&A	Supervision and Administration
SSE	South Shore (Ladder) Entrance
TDH	Total Dynamic (Pumping) Head
USACE	U.S. Army Corps of Engineers
V	vertical

SECTION 3 – METHODOLOGY

3.1 DESIGN

Development of the designs of the physical improvements described in this Phase II report were conducted in a manner that will allow for 1) an assessment of feasibility and; 2) development of cost estimates consistent with the level of detail typically found in a Phase II report. Consequently, the level of detail and the degree of optimization found in this report is not that normally associated with final plans and specifications. For example, in the development of the structural designs, more complex and sophisticated dynamic analyses of structures to evaluate interactions with rotating equipment has not been performed. Typically, only simple static analyses have been performed. Also, secondary members not associated with primary loads have not been designed. Likewise, detailed hydraulic calculations involving numerical or physical modeling has not been performed. The report identifies where such detailed analysis should be performed for final design.

Equipment selection for valves, pumps, screens, and electrical gear, etc. has been conducted with sufficient vendor input to establish feasibility and develop budget costs but not to procure such equipment for final design. Structural and mechanical details have typically not been included except as required to establish cost and feasibility.

Field investigations, interviews with project and District staff, and reviews of drawings and previous studies were conducted to establish the historical context of the facilities and any physical or functional/operational constraints associated with the proposed physical improvements. However, only a cursory attempt has been made to establish specific site conditions for example; soil conditions, interferences with existing field routed small conduit, piping, and other items not depicted on the drawings. For more discussion on the evaluation methodology of the existing AWS systems, see Section 2.2.

3.2 COST ESTIMATES

Conceptual level cost estimates for construction and for expanded parts inventories have been developed for the various alternatives described in this report. These estimates are summarized following the discussions for each of the alternatives. Detailed cost information for Little Goose alternatives is presented in Appendix C while detailed cost information for Lower Granite alternatives is presented in Appendix D.

Cost estimates were prepared using standard cost guides (Means, etc.), vendor information on specific equipment, vendor catalogs, previous reports produced by the Corps of Engineers and their consultants, as well as other similar projects supplemented by engineering judgement. Quantity take-off calculations and other cost details used in preparing this report are provided in the design documentation report (DDR) accompanying this document.

SECTION 4 - LITTLE GOOSE LOCK AND DAM

4.1 GENERAL

Little Goose Lock and Dam, completed in 1970, is located on the lower Snake River at River Mile 70.3. The normal range of forebay elevations is 633 to 638 ft. mean sea level (msl). The tailwater elevation typically varies between elevation 537 to 543.7 ft. The main project features of the dam include a powerhouse with six main turbine units, a concrete spillway with eight 50-ft. wide spillways separated by 14-ft. piers, a navigation lock, concrete and earth fill non-overflow sections, juvenile fish collection and bypass facilities, and a single adult fish ladder on the south shore and associated fishway collection system with entrances on the north shore, south shore, and along the downstream face of the powerhouse.

4.2 EXISTING SYSTEM

4.2.1 Existing System Description

4.2.1.1 Fish Ladder

The adult fishway at Little Goose consists of a fish ladder on the south shore with entrances on the south shore, across the downstream face of the powerhouse, at the non-overflow section between the powerhouse and spillway, and on the north shore (Figure 4.1). The fish ladder is 20 feet wide with a floor slope of 1 vertical to 10 horizontal. Along the length of the ladder are 90 dual-crest overflow weirs and 10 vertical slot and orifice control weirs. The overflow weirs have two 18-inch by 18-inch orifices at the bottom to allow low level fish passage. The orifice and vertical slot control weirs are 6 feet high with two low level orifices 18 inches by 37 inches high and a 1-foot wide variable height slot in the middle. A junction pool at the bottom of the fish ladder splits the ladder flow to the various fishway entrances. These include two entrances on the south shore (SSE-1 and SSE-2), three powerhouse fish collection channel entrances (NPE-1, NPE-2, and NPE-3) plus four floating orifice entrances, and three north shore entrances (NSE-1, NSE-2, and NSE-3). Entrances NPE-3 and NSE-3 are not normally operated. Flow to the north shore entrances is supplied by a continuation of the powerhouse collection channel that continues past the powerhouse running through the central non-overflow dam section and then through the spillway monolith to the north fishway entrance. The ladder exit is located at the forebay on the south end of the powerhouse.

4.2.1.2 Auxiliary Water Supply System

The auxiliary water supply system for the fishway provides supplemental flow to the north and south shore ladder entrances as well as the powerhouse collection channel entrances in excess of the 75 cfs supplied by the ladder itself. The auxiliary water supply system has three components. The first component, a gravity supply system at the ladder exit, supplies the upper portions of

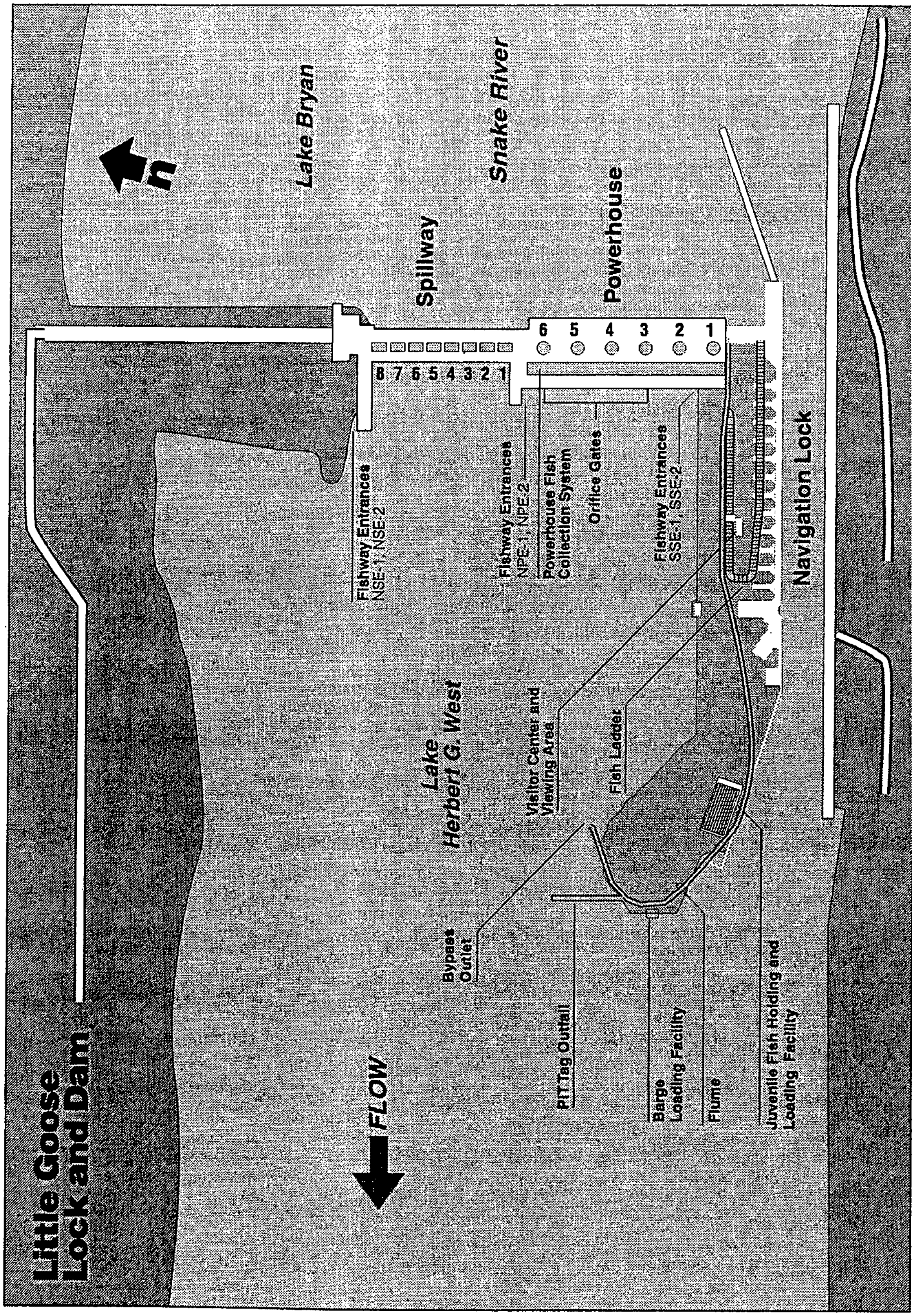


Figure 4.1 Little Goose Lock and Dam general site plan.

the ladder and contributes to the total ladder flow of 75 cfs, providing for a constant flow at all times in the ladder. The second component, a pumped system, supplies auxiliary water through diffusers in the floor of the ladder or channel to supplement the flow in the north and south fishway entrances and the powerhouse fish collection channel. The third component, a gravity supply providing excess water from the juvenile fish dewatering facility, discharges into the pump discharge chamber and supplements the larger AWS pumps.

The pumped system consists of three water turbine-driven pumps, with a total rated capacity of 2,550 cfs (including approximately 260 cfs turbine discharge) at 4 feet of pumping head. Each unit consists of a hydraulic turbine, a speed reducer, and an axial-flow, fixed-blade, propeller pump. These pumps, located in the Erection Bay on the south shore, discharge into a pump discharge chamber. From here, the flow is routed through three separate conduits to the entrance and lower ladder diffusers in the south shore fish ladder, the diffuser between the spillway and powerhouse in the central non-overflow section (Diffuser No. 12), and to the fish collection channel along the downstream powerhouse face. The pumps are manually controlled to provide the supplemental flow consistent with tailwater demands. Slide gates and orifices regulate this pumped flow into the system.

4.2.2 Existing System Evaluation

4.2.2.1 Hydraulic and Adult Fish Passage Evaluation

Flow rates supplied to the auxiliary water system: Flow is supplied to the auxiliary system from two sources.

- Approximately 240 cfs excess water from the juvenile fish dewatering structure
- Approximately 2,100 to 2,550 cfs combined pumped flow from the three turbine-driven pumps (including 260 cfs turbine discharge)

The pumped auxiliary flow is the dominant component of the total discharge. There is considerable uncertainty about actual flow rates supplied by the pumps. Evaluations conducted using model study ratings, computational analysis of the auxiliary water distribution system, and field calibration with reference to the rating curves supplied by the turbine–pump manufacturer indicated that pumped flow rates may fall as much as 34% below the original project design requirements (*Hydraulic Evaluation of Adult Fish Passage Facilities at Little Goose, Lower Monumental, and McNary (South Shore) Dams*), November 1988 [5]. Sources of the shortfall may include:

- Inefficiencies/head losses in the turbine penstock system
- Inefficiencies/head losses in the auxiliary water supply system that require operation with increased pumped head which in turn reduces pumped flow rates
- Excessive leakage that may be occurring from the collection channel which adds inaccuracy to the field rating of pumped flow rates and also requires additional flow to be supplied to the system to meet entrance criteria

- Turbine-pump units that are operating at less than design efficiency
- Evaluation errors

A subsequent study *(Turbine Drive Feasibility Study, Little Goose/Lower Monumental Fishwater Pumps)*, September 1989 [13], calculated turbine penstock system losses and determined that losses were higher than originally designed for.

Adult Fishway Performance: Substantial efforts have been made to refine fishway operation with the objective of complying with established criteria as described in the 2000 FPP [8]. In general the existing operation does comply. Exceptions are:

- Head differentials generated at the North Shore Entrances are approximately 0.8 ft. which does not meet the 1.0 ft. minimum FPP criteria.
- Transport velocities in the collection channel across the powerhouse and near the South Shore fishway entrance are lower than the 1.5 fps minimum FPP criteria.

Simultaneous operation of all three turbine-pumps is required to achieve this performance. Although fishway operation could be improved by reducing head losses in the penstock system and in the auxiliary water supply system and by reducing leakage from the fishway; it is unlikely that sufficient improvement could be achieved to allow criteria-compliant operation to be obtained through the use of just two turbine-pumps (thus allowing the third unit to be a backup). It appears that flow rates equal to the combined capacity of the three turbine-pump units must be supplied to the auxiliary water system for operations to be in near compliance with criteria.

4.2.2.2 Mechanical Evaluation

The pumped auxiliary water supply system for Little Goose consists of three identical horizontal Francis hydraulic turbine-driven pumps provided by Baldwin-Lima-Hamilton. The turbines drive the pumps through right angle speed reducers.

The pumps were manufactured by Baldwin-Lima-Hamilton. Impellers are 3-blade, 115 inches in diameter. Rated speed is 80 rpm; normal speed range is 60 to 80 rpm. Rated pump flow is 760 cfs at 4 feet pump head. Total unit flow, including turbine flow, is 850 cfs at 4 feet pump head.

The turbines were also manufactured by Baldwin-Lima-Hamilton. The turbines are horizontal Francis units with a rated speed of 690 rpm. The runners are 22 inches in diameter and have 13 blades. The turbines are rated to provide the required pump performance at 93 feet gross head. Turbine speed is adjusted by the wicket gates through an electric-gearmotor gateshaft operator.

The speed reducers were manufactured by Philadelphia Gear Company. They are right angle spiral-helical design. Ratio is 8.63:1 providing the required speed reduction from the turbine to the pump shaft. Speed reducers are rated for 562 hp at 690 rpm input. Gears and bearings are pressure lubricated.

Water-oil heat exchangers maintain oil temperatures. Kingsbury thrust bearings are incorporated into the speed reducers to handle pump hydraulic thrust requirements. A disk brake is installed on the input shaft to prevent backspin due to reverse flow when the pump is not operating.

All three fish pump units are operated during the fish passage season. The original control system reduced the wicket gate position to 60% open on the remaining turbines if one of the pump units shuts down to prevent overspeed due to the increased head available to the remaining turbines due to reduced penstock friction at the reduced flow. This has been recently modified to reduce the wicket gates to 80% to provide more water to the AWS on loss of a pump.

The Little Goose project has an established program of preventive maintenance for the AWS pumps. It is apparent that the program has been working well as the pump units appear to have been well maintained through the years despite continued maintenance cost constraints. As noted in the Fish Passage Plan for Little Goose, scheduled maintenance requiring dewatering of the pumps is to be conducted during January and February. Maintenance that does not have a significant effect on fish passage is conducted during the rest of the year and includes monthly, semi-annual, and annual maintenance.

A number of upgrades have been made over the years. These include:

- The turbines were rebuilt in 1994 and 1995. Work included replacing the original bronze runners with stainless steel, rehabilitating the spiral case, replacing the guide bearings, replacing the grease-lubricated wicket gate bearings with oiless bearings and new wicket gates. It is expected that this work would improve turbine performance as well as extend the turbine's life. The exact performance improvement could not be determined from project records.
- Grease lubricated pump bearings were replaced with water lubricated bearings.
- Pump shaft seals were reworked.
- Various improvements and upgrades have been made to unit instruments and auxiliaries.
- A comprehensive data indicating panel has been installed on the turbine floor. A recent upgrade was the installation of a Rosemont temperature monitoring and alarm panel.

As was noted in the previous section, a hydraulic study conducted in November 1988 indicated that the fish water pumps are not operating at their original design capabilities. Several reasons were offered but no final conclusions were made. Instead, with regards to the fish pump units, further studies in the form of more accurate flow measurements and/or detailed equipment studies were recommended to be made by Corps of Engineers turbine-pump specialists. It does not appear that those recommendations have been implemented. However, the study did find that with regards to total pump system output, current fish passage criteria was being met.

Pump Units No. 2 and 3 were observed to operate without undue noise or vibration. Cavitation could not be heard in the spiral case or draft tube areas of the turbines. Pump Unit No. 1 has a distinct vibration occurring at pump rotating speed (about 1/second at 70 ± rpm). It can be felt on the pump cover and speed reducer but not at the turbine coupling. Plant personnel reported that they were aware of the vibration but had not been able to locate its source. The vibration could be due to a bent shaft, an impeller out of balance if the bearings are very loose or an impeller blade that is not pitched properly. It is recommended that the cause of the vibration be determined during the next maintenance period.

Turbine wicket gates have been known to develop a "set" after remaining in one position for a period of time. The plant operators have had to bump the gateshaft operator back and forth for some time before the wicket gates will move. This process could take several hours. This problem has been essentially corrected in turbines 1 and 2 by cycling the wicket gates about twice a week . Turbine 3 is still causing problems. Plant personnel plan to investigate turbine 3 during the next maintenance period. The problem is not critical to AWS operation since, when shutting a turbine down, the penstock supply butterfly valve is used.

The original equipment, installed in 1970, has 30 years of service. The equipment has been overhauled, rebuilt and refurbished throughout the years. USACE ER 37-2-10 (Chapter 31, Appendix A), lists normal service life of house turbines, speed reducers, pumps and their major sub-components as follows:

- Turbine Runner 30 Years
- Pump Impeller 30 Years
- Thrust Bearing 35 Years
- Speed Reducer 40 Years

The service life of the equipment listed above have to be evaluated in the context of present condition and level of maintenance and upgrades. With the level of maintenance and upgrades at the plant, the pump units should have an effective service life of another 25 years.

Since the initial installation at Little Goose, system reliability has been tied to that of the spiral-helical speed reducers. The other major components of the system have proven dependable. Work required on either the turbines or the pumps have not resulted in substantial downtime during fish runs. The Phase I report indicated that the speed reducers were the weak link in the system, due to their age. As noted above, their age alone is not a good criterion for replacement.

The speed reducers were subject to major failures during the first 20 or so years of operation. The failures are summarized below:

Date	Speed Red.	Problem
October 1970	No. 1	Lube Oil Failure - Gears Destroyed
April 1981	No. 2	Gear Failed
July 1981	No. 3	Broken Gear Teeth
March 1986	No. 1	Vibration. New Gears Ordered
October 1986	No. 2	Replaced Bearings
March 1989	No. 2	Replaced Speed Reducer – Used Spare
January 1990	No. 2	Replaced Speed Reducer – Used Spare

Maintenance records available for review did not give complete details of failures in all cases. However, the records, and previous investigations, do indicate that most of the speed reducer failures have been related to manufacturer design deficiencies or quality control/manufacturing deficiencies. These problems have been corrected during the various rebuilds. The last recorded major failure was in January 1990. Since then, speed reducer reliability has been equal to or better than the other major pump unit components.

A spare Philadelphia speed reducer is kept on site. It is shared with Lower Monumental. Previous studies indicate that the spare speed reducer can be replaced within two weeks [12].

A spare turbine is stored at Lower Monumental. It is shared with Little Goose. Turbine replacement using the spare unit would take approximately 4 weeks. Lower Monumental also has casting patterns for the turbine runners.

Philadelphia Gear technical service personnel were contacted to determine replacement parts availability. Philadelphia maintains a stock of spare bearings and seals for the speed reducer. Major items, such as gears and shafts, can be manufactured from the original drawings by Philadelphia. Baldwin-Lima-Hamilton is no longer in business. However, Voith Hydro, York, PA, maintains drawings and patterns for Baldwin-Lima-Hamilton turbines, and can produce repair parts should there be major failures. As noted above, new runners were procured in 1995. Baldwin-Lima-Hamilton pump drawings and patterns are maintained by Ingersoll-Dresser Pumps, Liberty Corner, NJ, who can provide pump impellers and other major parts. Minor items, such as instruments and auxiliaries are readily available for all equipment.

The AWS pumps are isolated by intake and discharge bulkheads. Intake bulkheads are needed only when the intake water passage or pump impeller area is to be serviced or inspected. Discharge bulkheads are installed when a pump is not operating to prevent reverse flow through the pump. The bulkheads are installed by the plant's mobile crane. Plant personnel estimate installation of intake bulkheads takes about three hours on a weekday day shift and about 7 hours at other times due to the need to call out personnel. This is well within the criteria of providing an alternate source of EAWS within 24 hours on a major equipment failure event. Therefore, the existing bulkhead system is satisfactory.

4.2.2.3 Electrical Evaluation

Since the three auxiliary water pumps at Little Goose are hydraulic turbine-driven, only low-voltage electrical power is required for support functions and instrumentation. One critical support function is regulation of flow through the turbines via the electric operators connected to the turbine wicket gates. The gate operators are each equipped with a DC and AC powered motor. All three operators derive their AC power from one 480-volt panel board (FCQ1) with a single 225-amp main circuit breaker. This panel board and panel board FCQ2, also with a 225-amp main breaker, are both fed from a 200-amp circuit breaker in station service substation SQO. Substation SQO is fed from two separate sources with an automatic tie breaker in case of the loss of either main power source for the substation. An electrical fault in the circuit feeding the wicket gate operators downstream of substation SQO will tend to trip the 200-amp circuit breaker in substation SQO, leaving the turbines without AC power. Upon loss of AC power, the turbine shutoff valve closes preventing damage to the turbines. The valve is DC operated, deriving its power from the station batteries. The gates and valves can be manually operated although this is a somewhat cumbersome procedure. The operating mechanism for the turbine wicket gates was designed and installed to provide the operators with a constant source of power. Since the main regulating elements of the turbines, and therefore the fish water pump discharge, are electrically operated, it is essential that these systems be able to operate at all times. This points to an electrical system vulnerability that reduces the reliability of the pumps. The electric wicket gate operators are susceptible to a single mode failure, in that there is only a single source of power for all three operators. Failure in the single source of power would leave the turbines without electric actuation for an extended period of time. Alternate sources of power are available and could be connected to the turbine auxiliary systems through an automatic transfer switch. Although failure of the power system may be mitigated by a work-around plan (including manual actuation), this is a vulnerability that should be rectified.

4.2.3 Evaluation Summary

The existing auxiliary water system at Little Goose has generally been a reliable system over the years, thanks in part to a consistent maintenance program. The speed reducers, which were very unreliable in the early days, appear to have had the systemic problems corrected through numerous rebuilds and now match the other components in reliability.

However, a speed reducer failure would still cause major disruption to the AWS. This is presently fairly well mitigated, as there is a spare Philadelphia speed reducer on site. It is to be shared with Lower Monumental Dam which uses the same type and size. A previous report estimated installation of the spare speed reducer would require two weeks. Without the on-site spare, procurement of a new unit would require approximately 35 weeks with accelerated "sole source" procurement. The turbine/gearbox/pump system appears to have considerable remaining service life based on the performance history of comparable systems.

All three pumps are required to meet FPP criteria, although conformance to the criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and transport velocities at various locations in the fishway channel. Contributions from the dewatering structure at the juvenile facilities supplement the total attraction flow during the period that the dewatering facility is operational (approximately April 1 to December 15). Thus, there is no spare capacity at the project in the event of a single-pump failure. Certainly, the requirement for a minimum of a one-pump equivalent spare capacity is not being met at this project.

The electric wicket gate operators are susceptible to a single mode failure, in that there is only a single source of power for all three operators. Failure in the single source of power would leave the turbines without electric actuation for an extended period of time. Alternate sources of power are available and could be connected to the turbine auxiliary systems through an automatic transfer switch. Although failure of the power transfer system may be mitigated by a work-around plan, this is a vulnerability that should be rectified.

4.3 DEVELOPMENT OF ALTERNATIVES TO BE REVIEWED IN THE PHASE II REPORT

4.3.1 Phase I Report Alternatives

As was noted in Section 1.4, the objectives of this Phase II report are to evaluate, in greater detail, the alternatives previously identified in the Phase I report and recommend a selected alternative. Following the evaluation of the auxiliary water system at Little Goose, which was performed in the preceding section, and following a review of the alternatives identified in the Phase I report alternatives, it is clear that not all of the alternatives reviewed in the earlier report are suitable for a more detailed review. In this section, each of the Phase I report alternatives for Little Goose will be evaluated for merit for further investigation in this report.

4.3.1.1 Alternative 1 - Gravity feed through non-overflow section

In Alternative 1 in the Phase I report, it was proposed that a gravity feed system be developed to be routed through either the north, central, or south non-overflow sections of the dam and to be delivered to the AWS at one of several locations. The quantity of water to be supplied with this alternative would be equivalent to one pump resulting in spare capacity for the AWS. Since the existing auxiliary water system at Little Goose currently has no spare capacity, as noted earlier, and since the proposal has merit from a functional standpoint, more detailed review of this type of system is warranted and will be presented in this report as Alternative 1.

Alternative 1 in the Phase I report provided 700 cfs additional flow by installing one 80-inch diameter steel conduit cored through the north, south or center non-overflow section monolith. The energy would be dissipated by submerged cone, sleeve type or Monovar valves in an energy dissipation chamber and then discharged into the existing pump discharge chamber, fish ladder entrance diffusers, or the North Shore Fishwater Supply Conduit diffuser (Diffuser No. 12) at the north end of the powerhouse. It was noted that if the additional flow is discharged into Diffuser No. 12, the auxiliary water pump discharge chamber bulkhead to this diffuser would be closed, thus isolating it. Modifications would also be necessary to this diffuser to handle 700 cfs since it has a capacity of only approximately 275 cfs.

In the review of this alternative for development in the Phase II report, the following observations were made:

- The proposed 700 cfs additional water supplied by the gravity system from the forebay in this alternative does not fulfill the "one-pump spare capacity" requirement, which at Little Goose is 850 cfs. In the Phase I report, the 700 cfs was to be combined with about 180 cfs from the juvenile facilities dewatering structure to meet the full 850 cfs required capacity. Since the juvenile system is only operated from April 1 to December 15, while the ladder is operated year-round (except for periods of one week to one-month during January and February for maintenance), the excess water from the juvenile facilities is not available for a period of as long as three and one-half months depending on ladder maintenance requirements. This is judged to be unacceptable. Thus, the system should provide the full capacity of one pump or 850 cfs.
- The drawings in the Phase I report indicate a trash rack as being required for the forebay intake. Actual development of this intake will require juvenile fish screens conforming to NMFS juvenile screening requirements.
- The development of the forebay intake at the central and north non-overflow sections of the dam will require that the water be carried a significant distance to where it can be best utilized for the AWS, namely the pump discharge chamber. The extended length of piping required to route flow to this location plus the modifications required to accommodate the piping are seen as compelling disadvantages to these locations.
- Significantly more efficient and less costly energy dissipation configurations are possible than shown in the Phase I report.

4.3.1.2 Alternative 2 - Spiral case tap to pump discharge chamber

Alternative 2 in the Phase I report proposed to install a tap in the spiral case of the southernmost turbine in the powerhouse. The tap would consist of a bonneted slide gate and would feed flow to the Powerhouse Fish Water Supply Conduit through an energy dissipation chamber mined out of the downstream powerhouse wall. Like Alternative 1, the quantity of water supplied would be equivalent to one pump capacity. In the review of this concept for inclusion into the Phase II report, it was noted that disadvantages included the fact that this alternative would require discharge of unscreened flow, and consequently juvenile and adult fish, from the forebay into the AWS. This is judged to be an unacceptable configuration from a fish protection standpoint. Moreover, it was questionable whether the system could be operated with the turbine running because of a possible increase in shaft bearing vibrations and/or turbine runner cavitation. For the purposes of the Phase II report, it was concluded that this alternative should not be pursued further and was dropped.

4.3.1.3 Alternative 3 - Add two pumps north of north fishway entrance

Alternative 3 in the Phase I report would provide water to the AWS through pumping from the tailrace. It was proposed that a new pump station be developed on the north bank and that this facility would pump water to the central non-overflow diffuser. The equivalent of one pump capacity would be developed. As was noted above, since there is currently no spare capacity at Little Goose, and since no obvious fatal flaws exist with the concept, this alternative will be carried forward to the Phase II report as Alternative 2 for further design development.

In Alternative 3 in the Phase I report, an additional 700 cfs of flow was to be provided by adding two 350 cfs pumps to the auxiliary water supply system. The pumps would be installed in a pump intake structure in the area north of the north fishway entrance in the embankment. Two large-diameter conduits running along the roof of the existing fish gallery in the spillway monolith would supply an independent source of water to the diffuser in the central non-overflow section feeding the north shore fishway entrance. It was noted that modifications would be necessary to the central non-overflow section diffuser (Diffuser No. 12) to handle 700 cfs since the diffuser has a designed capacity of only approximately 275 cfs.

In the review of this alternative for further development in the Phase II report, the following observations were made:

- The proposed 700 cfs additional water supplied by the pump station in this alternative does not fulfill the "one-pump spare capacity" requirement of 850 cfs. As was noted earlier, in the Phase I report, the 700 cfs was to be combined with about 180 cfs from the juvenile facilities dewatering structure to meet the full 850 cfs required capacity. Because the excess water from the juvenile facilities is not available for a period of as long as three and one-half months, the emergency supply would be deficient during this period. This is judged to be unacceptable. Thus, the pump station should provide the full capacity of one pump or 850 cfs.
- Introducing the entire flow to Diffuser No. 12 or the area of the diffuser would negatively impact fishway hydraulics. Since the fishway is designed to introduce only 275 cfs at the central non-overflow section (Diffuser No. 12), introducing 700 (or 850 cfs) at this location would effectively rob the upstream portions of the fishway of 475 cfs (700 cfs – 275 cfs). This would result in reduced (or reversed) flow velocities in the upstream channel and the robbing of the south shore and north powerhouse fish entrances of required flow.

- The water is not withdrawn from the closest and most efficient location. The proposed location at the north shore of the project is over 1300 ft. from the proposed delivery location. A closer location should be investigated to reduce pumping costs from head loss in the pipes and avoid construction of the long piping system.
- Because of the eddy effects due to spill, small fish are likely to find their way to this area. Consequently, screening of the pump station will likely be required. Recent directives from NMFS [16] requiring screening of any new withdrawals in the forebay and tailrace areas further bolsters this conclusion.

4.3.1.4 Alternatives 4 - Enhanced preventive maintenance program, and Alternative 5 - "No Action"

Alternative 4 in the Phase I report proposed to increase the reliability of the existing turbine/pump system through a more aggressive maintenance program and through an increased inventory of spare parts with the objective of anticipating possible failures and working to prevent them, and institute a program of increased readiness to resolve them promptly if they occur. This alternative was identified as being attractive since the Phase I report had concluded that spare pumping capacity was currently available at the project since, by that analysis, only two pumps were required to meet FPP criteria. Thus, one pump would be available in case of failure of one of the other two pumps. The review in this Phase II report of the FPP, and hydraulic studies performed at the project indicate that all three pumps are required and are currently operated to meet (nominally) the FPP criteria. Thus, no spare capacity actually exists. Consequently, an enhanced maintenance program and increased spare parts inventory would only address minor failures of the AWS system; ones that would allow the system to be restored to full operating capacity in less than 24 hours (per the criteria). Long-term outages would mean extended periods of operation on less than three pumps. This was deemed to be unacceptable since it did not meet the operational criteria of the FPP. It is felt, however, that any proposal for increasing the reliability of the AWS system should include an enhanced maintenance program of the AWS to guard against system failures which might result in the failure of one or more pumps and should include reliability upgrades to the equipment to improve its overall reliability. An increased inventory of spare parts would contribute to this increased reliability. Thus, enhanced maintenance as a stand-alone concept is not viewed as being a viable alternative for the Phase II report, however, it should be reviewed as a supplementary alternative to one of the other alternatives and as such, will be included in the report as Alternative 4.

Alternative 5, the "No Action" alternative from the Phase I report, was not pursued further since by default, the existing system does not meet basic spare capacity needs or does it adequately address reliability concerns and as such, a proposal for "No Action" was not an appropriate response to these issues.

4.3.2 Other Water Supply Alternatives

In addition to the alternatives identified in the Phase I report, a review of other concepts was initiated to determine if other emergency water supply configurations were feasible. Some of the other concepts considered for this report included ones pursued in the Phase II report for Lower Monumental and Ice Harbor [2], concepts developed during a value engineering (VE) study for EAWS for these projects, completed in May 2000 [6], and a concept that was suggest by Ray Eakin, Operations Chief at Little Goose Dam, during the 60% Draft Report review meeting (see Appendix B for meeting minutes).

The most promising of the other concepts include one that is currently being developed more extensively for Lower Monumental in a separate study. This alternative would replace the existing three pump/turbine arrangement (which has hydraulic capacity of approximately 2,100 cfs) with a higher capacity system. Three new electric motor-driven pumps would replace the existing hydraulic turbine-driven pumps to increase the output capacity of each pump to approximately 1,050 cfs. Thus, two pumps would have the same capacity as the existing three-pump system. With this design, one pump would function as the spare pump, thus meeting the one-pump spare capacity criteria. Since Little Goose has almost an identical turbine/pump arrangement to Lower Monumental, such a concept should be applicable there also. This concept was adopted as Alternative 3, AWS Pumping System Upgrade, in this report.

The other promising concept, suggested by Ray Eakin, involves installing pumps through the roof of the existing AWS pump intake in the South shore tailrace area (thus utilizing the existing AWS pump intakes) and pumping into the AWS system. This is similar to Alternative 2 except that the pumps are located in a different place and pump to a different part of the AWS system. This concept was adopted as Alternative 5 in this report.

4.4 ALTERNATIVE 1 - GRAVITY FEED THROUGH NON-OVERFLOW SECTION

4.4.1 Design Development Criteria

In refining this alternative for the Phase II report, the following criteria were used for design development:

- The intake for the gravity supply pipe should be screened for juvenile fish. Recent directives by NMFS [16] require any new diversion of water from the forebay or tailrace area to be screened for juvenile fish. Existing diversions are accepted as long as diverted amounts are not substantially increased over original designed withdrawals (example, the existing AWS pump intakes).
- Generate uniform velocity distributions through juvenile fish screens in the forebay with velocity magnitudes that fully comply with National Marine Fisheries Service fry criteria.

- Develop a through screen velocity distribution control concept that minimizes complexity and yet allows field adjustment.
- Design the system to supply a discharge of 850 cfs at minimum forebay to tailwater differential.
- Maintain positive pressures throughout the water supply system to prevent development of cavitation and release of free air.
- Maintain positive flow control at a single location in the supply line over normal operating ranges (avoid shifting control).
- Design the system so that continuous, production operation can be effectively sustained at discharges ranging from 425 cfs to 850 cfs.
- Minimize the complexity and size of transport and energy dissipation structures.
- Introduce flow to the pump discharge chamber/attraction water system in a manner that sustains or enhances effective flow distribution.
- Avoid concepts that interfere with or require modification of existing features.
- Operation of the emergency water supply should be accomplished with a minimum of system configuration changes during the transition from normal to emergency operations.

4.4.2 New System Description

The following is a description of the major features and design considerations for development of the new gravity feed system. The new gravity feed system is depicted on Plates 1.1.1 through 1.1.5.

4.4.2.1 General

In Alternative 1, a new forebay intake routes flow by gravity via a new 90-inch steel pipe constructed through the South Non-Overflow Dam to the existing AWS pump discharge chamber at the Erection Bay. The forebay intake is comprised of two dual-flow traveling screens designed to exclude fish and debris. The screens are connected to two new steel flow chambers attached to the dam. Flow is controlled by a single 72-inch in-line sleeve valve located near the pump chamber and sluice gates located in the flow chambers. Energy dissipation is accomplished through both the valve and a new header/diffuser pipe located in the pump discharge chamber, which both dissipates energy and provides for uniform diffusion of flow in the pump chamber.

The operation of the Alternative 1 system is as follows:

- Upon failure of one of the three AWS pumps and identification of the need to operate the EAWS system, all of the AWS pumps are shut down and the bulkhead for the failed pump is placed in its appropriate slot. After placement of bulkhead, the remaining two operable pumps are turned back on.

- The traveling screens at the forebay intake on the EAWS system are started and allowed to flush themselves of any accumulated debris through use of the screen spray system.
- Since the sluice gates at the forebay intake are normally open and allow full hydrostatic head to be applied to the closed sleeve valve on the supply line, the sleeve valve on the EAWS system supply line is slowly opened to a pre-determined position based on the forebay and tailwater elevations to provide full design flow (850 cfs) to the pump chamber.
- Once the bulkheaded pump is repaired, the EAWS system is shut down in the reverse order indicated above.

4.4.2.2 Hydraulic/Fisheries

a. General Hydraulic Design Overview:

Hydraulic design of the gravity system focused on sizing screens, control of velocity distributions through the traveling screens, sizing of piping and control valves, evaluation of velocity and pressures generated through the system, consideration of alternative energy dissipation concepts, and consideration of alternatives for introduction of the flow into the existing pump chamber. Hydraulic designs were developed in compliance with the Design Development Criteria.

b. Forebay Intake:

The proposed dual-flow traveling screens were sized to supply sufficient screen surface area to pass a design discharge of 425 cfs per flow chamber with a minimum forebay operating pool (elevation of 633.0 ft) while sustaining approach velocities of no greater than 0.4 ft/s applied over the effective screen area (National Marine Fisheries Service fry criteria). Based on an effective area coefficient of 0.9 applied to the screen surface width, the screens were sized to extend to elevation 583.0 ft. with a 12.0 ft basket width (a standard width). This sizing is conservative in that active flow is sustained through screen baskets as they pass around the bottom of the screen (bottom area was not considered in sizing).

Since substantial excess head is available, uniform velocity distributions through the traveling screens could be generated through the use of velocity distribution control baffling that causes losses through the screen and baffling that greatly exceed energy influences in the screen approach and exit flow. By making uniform screen and baffling loss as dominant, local approach and exit velocity and loss influences have only secondary effects on local differentials across the screen. As a consequence local approach and exit velocity field characteristics will exert only secondary influences on through screen velocity distributions.

An internal baffling treatment was designed with input from a traveling screen vendor (U.S. Filter/Envirex). Through consideration of baffle placement and resulting internal flow path width, internal flow accelerations within the screen were evaluated. It was determined that maximum velocity influences on local head differentials across the screen would be approximately 0.1 ft. As a consequence, a baffle element fabricated from perforated plate containing 20-1.0 inch diameter orifices per square foot was selected. In combination with screen losses, net loss across the combined screen and baffle would be approximately 0.6 ft. This design would result in at most a ±5% variation in through screen velocities over the width of the screen. The baffle would be placed approximately 0.75-ft behind the screen and would extend from water surface El. 646.5 ft. (maximum design flood) to the bottom of the screen, wrapping around the bottom of the screen and back up the other side of the dual-faced screen once again to El. 646.5 ft. Based on input from U.S. Filter/Envirex it is proposed that the baffle be fabricated from 0.25 inch thick stainless steel plate. U.S. Filter/Envirex noted that they have produced screens of similar design that are currently in operation. An example of such a screen system is at the cooling water intake at Peach Bottom Nuclear Plant owned by Pennsylvania Electric Power.

To ensure uniform vertical velocity distributions it is proposed that a vertical slot orifice be used to restrict flow passage from the screen to the vertical flow chamber. Again the vertical slot was sized to cause head differentials that greatly exceed velocity and loss influences within the vertical chamber. With consideration of loss of slot orifice area due to structural members and the mid-screen vertical positioning of the exit conduit, a slot width of 1.44-ft was selected. This width would generate a minimum head differential across the slot of 2.0 ft, which would hold vertical flow distributions with ±2%. It is proposed that guides be provided into which orifice blades would be inserted to form the vertical slot. This would allow field modification of the vertical slot width to allow adjustment of the through-screen velocity distributions.

c. Supply Pipe:

As addressed in the Design Development Criteria, specific design objectives included:

- Assuring adequate line size to allow delivery of 850 cfs with a minimum forebay to tailwater head differential.
- Maintaining positive pressures throughout the system including the control valves.
- Prevent shifting flow control over normal operating ranges.

Hydraulic and energy grade lines were computed to compare alternative designs. For the proposed design, which includes an in-line sleeve valve placed at an accessible location mid-way along the supply line and a ported diffuser that discharges a broken jet into the pump discharge chamber, a 90-inch diameter line would be required to supply needed capacity. For discharges ranging from approximately 425 to 850 cfs, release flow control would be maintained at the ported diffuser. By maintaining approximately a 10 to 40-ft differential across the diffuser, positive back-pressure would be maintained on the discharge from the sleeve valve. This will be a sufficient back-pressure to prevent negative pressure development in the conduit below the sleeve valve (which could draw air through the air/vacuum valve). Head drops across the sleeve valve would range from 25 to 82-ft. These ranges of head losses and back pressures are conservatively within the operating capacity of the sleeve valve.

An alternative design that was explored used a butterfly valve instead of the in-line sleeve valve. The butterfly valve offers a less costly design. However, because the butterfly valve would be susceptible to cavitation damage if operated with the substantially reduced back-pressures that result when operated at reduced flow rates, the butterfly valve could only be operated over relatively narrow range of flow. System operation with butterfly valve control would be limited to replacement of a full pump's discharge capacity (approximately 850 cfs). The sleeve valve, on the other hand, can operate without cavitation damage, with reduced back-pressures. The sleeve valve therefore provides a more durable scheme with greater operating flexibility. Both designs would require similar piping and both would require use of the ported diffuser to minimize disruption of flow conditions in the pump discharge chamber.

Discharges could be monitored and set either through use of a flow meter (probably a multiple path ultra-sonic meter) or through field calibration, which establishes control valve set-points. Variation in discharge as a function of gross head will be minor. It is unlikely that control valve settings would be adjusted as gross head varies. Opening the control valve to a field calibrated set-point and leaving it at that setting, appears to be a reasonable operation. As a consequence a flow meter was not included in the design.

d. Energy Dissipation:

At a discharge of 850 cfs, line losses including screen, intake structure, and miter bend form losses, plus friction, amount to approximately 20 feet of head. Corresponding line losses at a discharge of 425 cfs would be approximately 5 feet of head. Additional excess head ranging from 65 to 92 feet must be dissipated. As discussed above, energy dissipation options include dissipating most of the excess energy at a dissipation structure (such as the sleeve valve) with secondary energy loss occurring with release of the flow into the pump chamber, or balanced dissipation of energy at both a control valve and at the pump chamber as would occur with the butterfly valve design.

Since both the sleeve valve and the pump chamber are designed as energy dissipation features, combined utilization of energy dissipation at the two features is both workable and appropriate. When utilizing the pump chamber as an energy dissipator the flow should be introduced in such a manner that it would not significantly change chamber hydraulics and thus, would not adversely affecting attraction flow delivery. It is proposed that a ported diffuser, running the length of the pump chamber, be used to disperse the inflow to minimize the influences of local concentrated jets and/or flow impingement. The diffuser would be fabricated from 90-inch diameter steel pipe with 4.0-inch diameter orifices placed at 9-inch centers in the lower quadrant of the pipe oriented into the chamber. Minor adjustments could be made either to orifice diameter or number of orifices to compensate for velocity head recovery within the diffuser and maintain uniform flow distribution over its length. Effectiveness of the diffuser in introducing flow uniformly will vary with the head differential across the diffuser. As designed, the diffuser will generate uniform distributions with high flows (approximately 850 cfs) and high head differentials. With reduced flows, velocity variations within the diffuser have greater influence on differential distributions. However, because flow rates are reduced, the resulting impacts on flow distribution from the chamber should be less significant. Consequently, an adjustable diffuser design would not be warranted. The diffuser would be submerged and placed below the existing diffuser, which receives excess water from the juvenile system.

4.4.2.3 Mechanical

a. Fish Screens:

As was noted above, exclusion of fish (and debris) from the intake is required for this system. There are a number of fish screening systems which have been employed by the COE and others. These include traveling screens, rotating drum screens, static screens with brush wipers, static screens with air burst systems, and rotating screens as are currently being prototyped at McNary Dam. The objective of the screening system for the forebay intake for Alternative 1 is to provide a safe, cost-effective, reliable system which meets the screening criteria established by NMFS.

One of the challenges faced with developing screens in the forebay is that there is little or no opportunity for developing flushing flows for debris removal and transport flows to carry fish past the screens except in front of the spillways and the turbine intakes. In locations where it is practical to locate an intake for this project, the reservoir environment is more or less that of a quiescent lake with little or no perceptible velocities near the dam. As such, static screens which rely on air-burst systems (or water back flush systems) to remove debris, risk having the material re-attached to the screen as flow through the screen is re-started. Screens can be mechanically cleaned with brushes with material physically removed from the screen face. Once again, unless there is sufficient flushing flow, the debris, once detached, will re-attach at another location. Rather, it seems that removing the material from the flow path using a moving screen face and an above-surface spray system appears to have merit. This is the basic premise of traveling screens.

Historically, traveling screens have been notorious for maintenance problems with a myriad of moving parts, some of which require complete removal of the screen for service. Adverse environments (excessively silty or sandy source water) contributes to premature failure of critical moving and rotating components. More recently, with the advent of newer screen technologies, the more problematic components (the foot shaft and lower sprocket systems) have been replaced on some screens with continuous steel guide rails which allows the screen chains to roll around the foot terminal in a 180 degree arc, thus eliminating any moving parts which cannot be accessed from above the water surface. With the development of dual-flow screens, which draw water from both screen faces (both the upward moving as well as the downward moving face) and allow water to discharge out one side, a dramatic reduction in the civil works required has been made possible.

Traveling screens developed for fish diversion leave fish in the flow rather than scoop fish out, as is more common on traveling screens at retrofitted intakes. Thus, debris which is impinged onto the screen face, travels up the screen (or down the screen and then up the screen as would be the case for a dual-flow screen) and is flushed off the screen face by water jets. Debris and flushing flow is routed back to the forebay or can be routed downstream. Fish remain in the forebay.

As was noted above, in the development of the fish screening system for Alternative 1, a traveling screen vendor (U.S. Filter/Envirex) was approached and provided basic design information for the project. Selected re-configuring of their standard Dual-Flow Traveling Water Screen to include additional static porosity control features downstream of the traveling face, has resulted in a design which will provide a uniform approach flow, positive fish screening and protection, and improved maintenance and reliability characteristics. Screen mesh to meet NMFS criteria would be applied to the moving panels. The screen material selection would be accomplished during final design and might be either metallic or non-metallic materials. The screen's open side would be attached to a new steel flow chamber through which flow would be routed to the 90-inch supply pipe. Two such screens would be required to meet the flow capacity requirements for the project. To guard against floating debris impacting the more delicate moving screen faces, a removable trash rack has been included. The rack extends to El. 625.0 ft or approximately 8 feet below the normal low operating water surface at El. 633.0 ft.

Water supply for the debris spray system would be provided by a small pumping system located on the equipment. The source of water for the pump would be the screened water in the flow chambers. Additional filtration for the spray system would be provided by an in-line filter.

One of the design issues to address during final design would be the susceptibility of the screens to icing conditions. Since the screens would not normally operate during January and February, which are critical months from an icing standpoint, the issue of operating during severe cold temperatures should not be a concern. Also, because of the quiescent nature of the forebay, frazil ice, the primary concern for screen plugging, should not be an issue. The trash racks should protect the screens from surface ice damage. Also, selection of non-metallic screen material should be investigated from an ice mitigation standpoint.

b. Flow Control and Air/Vacuum Release Equipment:

Flow control for the pipe system is provided by an in-line 72-inch sleeve valve as discussed in Section 4.4.2.2. Valve discharge would be controlled by an electric or hydraulic geared actuator with a 5 to 10 hp electric motor. To avoid over-pressurizing the ported diffuser pipe proposed for the pump chamber, position limit switches on the actuator would be utilized to limit discharge through the valve. The valve has a total static design head of approximately 98 feet of water at a maximum design flood of 646.5 feet. The valve is located in a new concrete valve pit south of the Erection Bay. Because the groundwater at the excavation is likely to be above the bottom of the valve pit, a concrete bottom slab is added to the valve pit. Also, because of the groundwater, the valve pit design would need to address potential buoyancy issues. A small sump pump would be required to control accumulations of water in the pit.

Additional on-off flow control is provided in the new flow chambers in the forebay at the intake where two sluice gates (one in each flow chamber) provide isolation for the pipe downstream. These gates would not be used for throttling. Rather, they would only be used as isolation valves. Total design seating head on these gates is approximately 41 feet of water under maximum design flood conditions in the forebay. No unseating head design is required. These gates would be fitted with electric or hydraulic actuators.

Combination air/vacuum release valves are provided in two locations. One is located just as the pipe emerges from the downstream wall of the South Non-Overflow Dam while the other is located just downstream of the 72-inch sleeve valve. The valves protect the pipe from excessive negative pressures during emptying of the pipe and allow accumulated air to be released during filling of the piping. Since the fill and emptying rates of the relatively short pipe can be strictly controlled, the sizing of the valves would be based on the desired operating plan for the pipeline.

c. Piping and Supports/Restraints:

The 90-inch supply pipe is proposed as an epoxy-lined welded steel pipe meeting AWWA C-210 with a painted external coating system for above-grade installation and a polyurethane coating system meeting AWWA C-222 below grade. Alternative interior and exterior coatings meeting AWWA requirements are available including mortar lining for the interior and tape coating for the exterior. Piping design shall be for all relevant internal pressure loads and externally applied loads in the buried section of the pipe. Thrust restraints are provided at pipe bends and would be sized for the maximum design load due to static and transient pressures, where applicable. To guard against differential settlement at the soil/structure interface, harnessed flexible couplings would be added where the pipe transitions from soil to concrete structures. Dewatering of the pipe trench and will likely be required during construction due to anticipated high groundwater in the area due to the proximity of the tailwater. A means of gaining access to the pipe interior for inspection should be provided. The most reasonable location for these access ports would be in the sleeve valve pit discussed above. Filling of the pipe would be accomplished by a small valved port at the Tee section of the pipe in the forebay. This valve would be operated from the screen platform.

Installation of the 90-inch supply pipe will require penetration of the concrete non-overflow dam (approximately lineal 45 feet of concrete) as described in Section 4.4.2.4, and penetration of the south wall of the pump discharge chamber (7-foot thick concrete wall). It will also require excavation of approximately 1250 cubic yards of earth in the area south of the Erection Bay where the pipe is buried, demolition of approximately 20 feet of the buried temporary fish ladder used during construction of the dam, and temporary removal of Vault C associated with the excess water system from the juvenile fish facilities. A review of buried utilities shows that an existing 39-inch pipe will also have to be skirted during installation of the pipe (see Plate 1.1.1). Miscellaneous buried electrical conduit and small diameter piping may also be impacted during pipe installation.

d. Header/Diffuser Piping and Supports:

The header/diffuser piping in the AWS pump discharge chamber would be fabricated out of flanged 90-inch welded steel pipe. Diffuser modifications to the raw pipe would consist of adding three arrays of 4-inch diameter holes located in the lower left quadrant of the pipe (looking downstream). Flanged sections would allow the pipe to be installed through the construction opening in the south wall of the pump chamber. Pipe supports for the pipe in the chamber would be designed for a radial thrust load of approximately 1250 lbs. per lineal foot in the opposite direction of the diffuser jets, gravity loads for the empty pipe, and gravity and seismic loading as well as Westergaard loading for the submerged pipe. Since the pipe is submerged during normal operation, the internal pipe water weight would not be added for gravity loading of the pipe.

4.4.2.4 Structural

a. Dam Stability Issues:

A relative assessment of the impacts of the new forebay structures and 90-inch concrete core on the stability of the South Non-Overflow Dam was performed. Based on that analysis, the additional overturning moment due to the horizontal seismic forces from the forebay structures (and confined water) and the decrease in the concrete mass of the dam due to the removal of the concrete core, are lower than the restoring moment caused by the new vertical loads of the new structures in the forebay and the decrease in seismic overturning forces due to the removed concrete. Thus, the impact to overall dam stability is acceptable.

b. Forebay Intake Structure:

The intake structures are composed of three main components; the (two) flow chambers, the equipment platform, and the (two) traveling screens. Each flow chamber routes flow from a single traveling screen (see discussion above on traveling screens) to the 90-inch supply pipe. The design of the flow chambers is such that flow through the screens is initiated by a 1 to 1.5-foot differential head through a tall vertical slot in the upstream side of each flow chamber. Thus, the flow chambers become large negatively-pressurized chambers (relative to the forebay). The design head loss for the design of the flow chambers is 4 feet of water which will far exceed the normal operating head loss through the control slot. The chambers are comprised of vertically stacked horizontal frames over which spans steel plate to make up the skin of the chambers. The screens are attached on their downstream side to the upstream side of the flow chambers and transfer horizontal loads to the structures. The vertical loads for the screens are assumed to be carried by the equipment platform at the top although some vertical load transfer through the flow chambers to the forebay wall will occur. The flow chambers are attached to the upstream forebay wall with surface-mounted base plates using rock bolts installed by divers. Water level sensors monitoring the water surface elevations at the forebay and inside the screens should be included to alert plant operators to a fouled screen condition

The equipment platform, as noted above, supports the traveling screen equipment, provides access to the equipment, and supports the relatively shallow trash racks which protect the upper reaches of the screens from wave-generated debris damage. The platform is horizontally braced. It is also vertically braced back to the forebay wall at each side and at the center of the platform. Attachments to the concrete forebay wall are made with surface mounted base plates using rock anchors. Grating and handrails provide access around the equipment. Portions of the platform framing would be removable to allow for access for maintenance of the sluice gates.

Since portions of the steel structure located below the water surface would not be designed to be removable, and therefore could not be maintained like other steel structures, the coating system would need to be designed for the life of the structure. Conventional paint systems employed on hydraulic structures will perform adequately for many years, but historical evidence suggests that they will fail well before the 50-year design life proposed for this structure. Cathodic protection system using impressed current have been successful at protecting steel structure in water. Poor reliability of these systems, typically due to failure of the protection system itself, has led to poor long-term performance. Metallized coatings (essentially a sacrificial metal coating sprayed onto the steel) are gaining increased popularity due to improvements in technology resulting in cost which are now competitive with high quality paint systems. The durability of metallized coatings is very good and can approach the 50-year design life. Consequently, it is proposed that a zinc-aluminum metallized coating system be employed for the structure.

c. Concrete Removal:

Two areas require significant concrete removal to install the 90-inch supply piping for this alternative. The first is the forebay wall which is nominally 45 feet thick at the point of penetration. Two strategies for removing the concrete include diamond wire sawing, and core drilling and splitting/chipping. A caisson would be required for the upstream face of the dam to allow final penetration to the forebay. The work face, however, is assumed to be the downstream face of the dam. This will require construction of temporary access platforms to reach the work area. Good access for concrete removal by crane exists from below, however, the existing fish channel, which is located above the penetration, will prevent direct access to the face. Depending on when construction takes place, weather-related issues (icing, cold weather, etc.) may complicate construction. Since the structure is mass concrete, little impact on the design of the monolith is anticipated although this assumption should be checked during final design. The pipe would be grouted in place after installation. Seep and thrust rings would be incorporated into the penetration design.

The second main concrete removal activity is located at the 7-foot thick south wall of the pump discharge chamber where the 90-inch pipe enters the pump discharge chamber. Since the north face of the wall can be dewatered during the fishway maintenance window (January and February), and since excavation at the south side of the wall can be accomplished independent of project operations, good construction opportunities exist for this work. An existing 48-inch excess water diversion pipe from the fish facilities is located directly above the work area and would have to be supported independently during construction. Vault C, located on the 48-inch pipeline and directly above the excavation for the 90-inch pipe, would have to be removed and replaced after installation of the new pipe. Diamond-wire sawing or core drilling and splitting would be appropriate concrete removal techniques for this area. The concrete structure should be analyzed for the new penetration during final design although the close proximity to other massive walls intersecting with this massive wall should make the analysis straightforward.

4.4.2.5 Electrical

a. System Loads:

The electrical power requirements of the proposed gravity water supply system are located at the forebay intake and near the discharge end of the supply pipe at the pump chamber. Both of these areas would require small 480-volt circuits. These circuits would be from spare, or out of service circuits, in the 480-volt power centers. Control centers, CQ01, CQ02, CQ03 and CQ04 all have sufficient capacity and either abandoned or spare circuits to accommodate this load. These control centers derive their power from both station service busses.

The forebay intake has primarily small 480-volt motor loads for the fish screens, screen spray system, flow control equipment (sluice gate actuators), and lighting; and 120-volt control power for instrumentation and convenience receptacles. The two screens typically require a 1 to 1.5 hp electric motor each to circulate the moving screen. A single 5 to 10 hp pump for the screen spray system is anticipated. The two sluice gate actuators have similar requirements with either an electric or hydraulic operator.

The 72-inch sleeve valve near the discharge potions of the facility will also require similar amounts of power. The valve will require a 5 to 10 hp drive system, for either an electric or hydraulic operator. Status and control signals will need to be taken from and brought to the supervisory system.

b. Power Supply and Routing:

This system will require two 480-volt circuits, one each feeding the upper and lower areas. A 480-volt power distribution panel will be provided for each area, and local 120-volt power will be provided through a step-down transformer, feeding a 120-volt distribution panel. The 480-volt system will provide power for screen and sluice gate motors, and the 120-volt panel will provide power for controls, receptacles, and lighting. New power and control circuits will be routed though the existing cable tray and conduit system to the central or north non-overflow section. From here, the concrete will have to be bored to get the power to the upper and lower areas.

4.4.3 Estimated Construction Costs

The following table presents the estimated construction costs for Alternative 1. Detailed cost information for Little Goose EAWS system alternatives is provided in Appendix C.

DIRECT CONSTRUCTION COSTS	**$2,876,703**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$143,835
General Contractors Overhead and Profit (26.5%)	$800,443
CONSTRUCTION SUBTOTAL	$3,820,981
Construction Contingency (25%)	$955,245
TOTAL CONSTRUCTION COSTS	**$4,776,227**
PLANNING AND ENGINEERING (22.5%)	$1,074,651
CONSTRUCTION MANAGEMENT (12.5%)	$597,028
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$6,447,906**

4.4.4 Conclusions

The following section discusses how Alternative 1 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: Alternative 1 accomplishes the goal of providing one-pump "spare" or emergency flow capacity to the auxiliary water system. Moreover, it delivers this flow to a desirable location in the AWS pump chamber making it a very flexible system in terms of project operations.

The system can be brought on line in a relatively short period of time with the greatest amount of time likely to be associated with the bulkheading of the failed pump. After ensuring that the traveling screens are free of debris, start-up should be a matter of turning on the screen drive and spray systems and allowing the screen to cycle around.

Design and Construction Issues: The system is a fairly straightforward design; similar components of which have been designed at other COE projects. The system components should have a relatively long life. The traveling screens, the most complex of the mechanical systems, have good durability. Periodic replacement of drive or spray system components, and repair of damaged screen panels is likely for this equipment, but overall, the screens should have good, long-term performance. The proposed metallized coating system for the underwater steel flow chambers which are not easily removable, nor intended to be removable, should perform well and give excellent durability.

Like the design, the construction complexity is moderate. Much larger concrete removal projects than this one have been carried out under more severe circumstances (example, the construction of the Lower Monumental fish gallery). The excavation work should be relatively easy given the lack of sensitive adjacent structures. Existing utilities will need to be supported (or removed and replaced) during construction.

For the most part, construction of Alternative 1 will have minimal impact on the operations of the dam. The major work effort occurs in the large open area south of the erection bay where there is little apparent operational activity. The forebay work would be constructed relatively independent of dam operations with no unit outages foreseen. Periodic blockages of the intake deck will occur as equipment is installed in the forebay. The operations of the make-up water intake for the fish collection gallery at the south non-overflow dam may be impacted on a short-term basis as the equipment is installed underwater on the face of the dam. Care must be exercised to minimize disturbances in the area of the adult ladder exit near the forebay construction site. No specific construction timing constraints are seen due to this, though.

Impacts to the normal operations of the AWS system during construction should be minimal. The work required to install the piping inside the pump chamber, which includes penetrating the 7-foot thick south wall of the chamber, should be able to be accomplished during the normal ladder maintenance window. All other construction activities are separate from the AWS system.

<u>Operations and Maintenance Issues:</u> The systems associated with Alternative 1 should be very compatible with current dam operations. Except for the penstock piping on the downstream face of the south non-overflow section and the screen equipment platform on the forebay side of the dam (both of which occupy areas not normally accessed), there are no physical features which restrict access or otherwise appear to interfere with existing operations.

The components of the system represent known technologies with proven reliabilities. The traveling screens are simple, reliable pieces of equipment while the only other mechanical components, the sleeve valve and sluice gates, are proven designs and are also very reliable.

Given the benign nature of the operation of the screens (turn them on and let them run), the operability of the system should be quite straightforward and should have minimal impacts to the day-to-day operations of the dam. Given the fact that the system is designed specifically for emergency conditions, operational impacts of the system are even further reduced.

The traveling screens will likely require the most maintenance of any of the components of the EAWS. Once the fish screens are confirmed to be free of any accumulated debris, it is simply a matter of opening the control gates and valves. As was noted earlier, it is anticipated that periodic inspection of the screen panels for damage, the drive system for wear, and the spray system for effectiveness will be required. Given the anticipated low usage of the system, the greater risk is perhaps lack of use. Consequently, the equipment should be run periodically and inspected to ensure that it is available when it is needed. If used for more extended operation (example, used as a flow supplementation system), more maintenance would be expected than in its designed role as an emergency water supply system. Either role would appear to be feasible.

The trash racks would require periodic cleaning at a frequency determined by use. The cleaning method would be similar to that employed for the AWS pump intakes which is to lift them with a mobile crane and "swoosh" them off in the forebay. Debris that does not come free would be removed by hand.

Construction and O&M Costs: The estimated construction costs for this alternative are presented in Section 4.4.3 and compared to the other comparable alternatives at Little Goose (Alternatives 2, 3 and 5), are the lowest of all the Little Goose EAWS alternatives. However, they are quite close to Alternative 5 and thus can be considered as being virtually the same at this level of design development.

The daily maintenance costs for this alternative are expected to be lower than Alternative 2 (the pumped tailrace alternative) which has both fish screens and pumps), but higher than those for Alternative 5 (the pumped alternative using the AWS pump intakes) which has pumps but no screens to maintain. From a long-term maintenance standpoint, the simplicity of the screens and the relatively low cost of the equipment ($200,000 for each screen compared to $500,000 and up for each pump in the other alternatives) may in fact lead to an overall lower maintenance cost. Major pump maintenance work, should it be required, will require significantly greater expenditures in maintenance dollars than would be expected with periodic replacement of relatively modestly priced screen panels, small drive motors, or replacement of miscellaneous spray system components.

The cost of operating the EAWS system for Alternative 1 must include the value of the energy lost while diverting 850 cfs of water with over 100 feet of head from the project turbines. Assuming that the system is operated for a total of one month a year, and assuming the value of power at $17.45 per MW hour [2] and a turbine efficiency of 86%, the value of the lost energy would be just over $100,000 per year. This compares with just over $10,000 per year in energy costs for a pumped tailrace system with comparable discharges and durations. It should be noted that during periods when the project hydraulic capacity is exceeded (requiring spill), this apparent loss of revenue is not accurate since the water would be spilled at the spillways instead. During these periods, the water would be effectively "free". If the use of the system is expanded to provide a source of supplemental flow for the AWS system, the value of the lost energy will obviously increase. Energy recovery generators could be installed in the gravity supply system, but these would also increase the complexity and expense of the system and reduce the reliability of what is intended to be an emergency backup system.

Other Issues: It has been suggested in review meetings during the development of this report that the use of the EAWS system might eventually be expanded to include its use as a supplemental source of water for the AWS pumps. While not specifically designed with the ability to accomplish this in mind, this alternative, with the significant amount of potential head available, is certainly capable of providing supplemental flow to the existing pump chamber with all the AWS pumps running. It should be noted, however, that simply adding flow to the AWS system at the pump chamber may not necessarily significantly increase discharge as might be assumed. As more flow is added to the pump chamber, the water level in the pump chamber rises. As the water level rises, the pump discharges start to fall off. The hydraulic issues and mechanical/electrical consequences of operating the system in this manner were not evaluated as they were beyond the scope of this project. A separate evaluation of the entire AWS system with this in mind should be performed before the system is used in this manner.

Conclusions: Alternative 1 is a very viable alternative with advantages in simplicity of design, flexibility in operation, good constructability, good O&M characteristics, and the lowest construction costs of the other alternatives. The operations costs associated with the value of lost energy (during periods when the project hydraulic capacity is not exceeded) is the highest of the alternatives. It is also very flexible in terms of adaptation as a supplemental flow for AWS uses.

4.5 ALTERNATIVE 2 – NEW PUMPED SUPPLY FROM TAILRACE

4.5.1 Design Development Criteria

In refining the tailrace pump station alternative for the Phase II report, the following criteria were used for design development:

- The pump station should provide 850 cfs additional emergency flow capacity to the auxiliary water system (one-pump equivalent capacity).
- The optimal location to introduce the new flow capacity in order to be compatible with the existing hydraulic design of the fishway would be at or near the pump discharge chamber near the existing AWS pumps in the Erection Bay.
- The intake for the pump station should be screened for juvenile fish. Recent directives by NMFS [16] require any new diversion of water from the forebay or tailrace area to be screened for juvenile fish. Existing diversions are accepted as long as diverted amounts are not substantially increased over original designed withdrawals (example, the existing AWS pump intakes). New screen systems should be sized to fully comply with NMFS velocity criteria.
- Fish protection screens and cleaner systems should be designed to maximize reliability and minimize maintenance.
- The hydraulic conditions at the pump intake should be appropriate to provide efficient, vibration free pump operation.

- The new pump station location should not significantly affect plant operations.
- Operation of the emergency water supply should be accomplished with a minimum of system configuration changes during the transition from normal to emergency operations.
- The pumps should be readily serviceable. If possible, pumping equipment should be serviceable without dewatering the pump sump.
- Techniques for construction of the pump station structure should minimize dewatering during construction.
- The location and operation of the pump station should not negatively impact adult fish upstream passage.
- The pump station should not negatively impact turbine draft tube hydraulics.

Review of potential sites for a new pump station concentrated primarily around the area immediately surrounding the existing pump chamber. The most promising location appears to be immediately downstream of the tailrace deck at Units 2 or 3 in the area of the bulkhead slots for the draft tube dewatering bulkhead. This site has distinct advantages in that it is near the fish pump discharge chamber where the water can be used most advantageously, an existing conduit is readily available to route the flow to the chamber (the North Shore Fishwater Supply Conduit), and plant operations would not appear to be significantly impacted by a new facility at this location. Other sites downstream of the existing fish pump intake would require routing of the water through a new conduit to the pump chamber.

4.5.2 New System Description

The following is a description of the major features and design considerations for development of the new pumping station. The new pump station is depicted on Plates 1.2.1 through 1.2.3.

4.5.2.1 General

In Alternative 2, a new emergency pump station is constructed off the tailrace deck above the draft tube discharge at Turbine Unit No. 2. Two new modular steel structures are bolted to the downstream face of the dam above each discharge opening creating two new pump discharge chambers at the draft tube bulkhead gate slots. Backflow is prevented by a flap gate on the discharge of each pump. Two 12 ft. by 8 ft. openings are cut into the downstream concrete wall of the North Shore Fishwater Supply Conduit. The water from the four new pumps is discharged through these openings into the conduit by gravity flow. Within the conduit the water is routed to the north to Diffuser No. 12 and to the south to the main pump discharge chamber to serve the rest of the auxiliary water system. When the primary AWS pumping system has been restored to full capacity, the emergency supply is shut down.

The operation of the Alternative 2 system is as follows:

- Upon failure of one of the three AWS pumps and identification of the need to operate the EAWS system, all of the AWS pumps are shut down and the bulkhead for the failed pump is placed in its appropriate slot. After placement of bulkhead, the remaining two operable pumps are turned back on.
- The water control gates at Diffuser No. 12 are set to their pre-determined positions.
- The screen cleaners at the tailrace pump station for the EAWS system are started and allowed to rid the screens of any accumulated debris. Since the EAWS pump station pump chamber is normally hydraulically connected to the North Shore Fishwater Conduit (the two 12 ft. by 8 ft. bulkhead gates are normally left open), the pump station is ready to be brought on line.
- The pumps are started and flow is initiated to the tailrace pump station pump chamber and through the two openings in the wall of the North Shore Fishwater Conduit to the AWS pump chamber and to Diffuser No. 12.
- Once the bulkheaded pump is repaired, the EAWS system is shut down in the reverse order indicated above.

4.5.2.2 Hydraulic/Fisheries

a. General Hydraulic Design Overview:

Hydraulic design of the emergency pump station initially focused on the North Shore Fishwater Supply Conduit to determine the compatibility of the introduced flow with the function of the existing water supply. Head losses associated with flow passage through the conduit and thus lift that must be supplied by the pump station were then determined. Alternative station and sump designs were considered with the objectives of providing good approach flow hydraulics to the pumps while finding a design that would best fit into the available space. Station designs that included two and four pumps were considered. Hydraulic designs were developed in compliance with the Design Development Criteria as stated above (Section 4.5.1) as well as pump intake design standards.

Influences of the flow introduction to the main pump chamber on flow distribution from that chamber were also considered. Because the flow will be introduced at a relatively low velocity (approximately 3.5 ft/s), local influences will not be sufficient to preclude effective distribution and delivery. However it is likely that local influences on circulation within the chamber will be sufficient to require adjustment of control gate settings at diffusers.

b. Fish Screens:

The fixed plate fish screen was sized based on an approach velocity of 0.4 ft/s and an effective screen area ratio of 0.9. It is proposed that through screen velocity distributions would be controlled through use of a spatially varied porosity control backing. Through use of varied backing, head losses across the screen/porosity control system could be minimized thus reducing adverse effects on pump performance. Use of a physical model study would likely be required to develop the design of this porosity control.

c. Pump Station:

The proposed pump station includes four equally-sized pumps. The pump station is comprised of two modular structures, each of which contains two pumps. Each pump sits in a short pump bay, approximately 14 feet long by 15 feet (two pump bell diameters) wide. Use of short pump bays is possible since each pump is fitted with a vaned basket to straighten flow and dissipate vortices. The pumps discharge horizontally into pump discharge chambers (two pumps per chamber) where the water is then directed down and through rectangular openings to the North Shore Fishwater Supply Conduit. A flap gate prevents backflow when the pumps are not operating.

A number of alternative sump configurations were considered and eventually ruled out for various reasons. Primary objectives were to provide good approach flow hydraulics to the pumps while finding a design that would best fit in the available space off the tailrace deck.

Two and four pump configurations were investigated with consideration given to facility symmetry, reasonable pump sizing, and the restrictions on sizing and placement of the openings into the fishwater supply conduit (two openings). A standard rectangular intake structure and a Type 10 formed suction inlet (FSI), based on Hydraulic Institute Pump Intake Design Standards (1998), were first considered. To limit velocity head losses, the maximum desired flow velocities at the pump throat and pump bell were set at 12 ft/sec and 5.5 ft/sec. The resulting pump columns and pump bells diameters were 59 and 87 inches respectively for 223 cfs pumps and 83 and 122 inches for 445 cfs pumps. Analyses of alternative designs showed that a four-pump station results in substantial shortening of the required pump bay. As a consequence, only four pump configurations were considered.

Various pump bay designs were investigated based on a standard rectangular intake structure and a Type 10 formed suction inlet (FSI). Both supplied good approach flow hydraulics, but resulting bay lengths were longer than desired, which caused the resulting structure to extend an excessive distance out from the tailrace deck. An alternative that was considered would remove the pump bays entirely by providing an attachment to the pump bells that would provide adequate approach flow. This however would directly expose the pumps to debris loading and would entrain fish which was deemed unacceptable. In order to shorten the intake structure the pumps were placed in a shortened intake bay with a vaned basket placed over the pump bells which improved approach flow hydraulics. Fish and debris will be effectively excluded by the fish screens. Influences of the fish screens on required Total Dynamic Head (TDH) supplied by the pumps and on debris maintenance are discussed later.

The shortened pump bays and pump placement retain critical features as established by the Hydraulic Institute Pump Intake Design Standards (1998). The bay width is set at two pump bell diameters, and the minimum submergence requirement for the pump is met.

The vaned baskets added to the pump bells provide adequate approach flow conditions to the pump. These baskets have vanes spaced at 7.5 degree intervals around the perimeter (48 vanes total). The depth of the vanes must be equal to or greater than the spacing between them. The bottom of the basket is made of commercially available grating where the grid sizing is similar to the vane spacing and where the depth of the grating is equal to or greater than the spacing between grating bars. By maintaining the depth to spacing ratio at or greater than one for both the vanes and the grating, vortices that form in the vicinity of the pump bell will be dissipated. If the vanes or grating are not deep enough the vortices will simply pass through the vanes/grating. The vanes and grating also help to dissipate turbulence and reduce pre-swirl, thus providing uniform approach flow conditions to the pump.

With the sump designed, the pump discharge and pump discharge chamber configurations were addressed. The design was selected to minimize structure extension away from the tailrace deck while supplying adequate access. Direct piping from the pump to the North Shore Fishwater Supply Conduit was not used to avoid interference with draft tube bulkhead operation. With the proposed design, the pumps discharge horizontally into the chamber. A full velocity head loss occurs at this location.

Head losses associated with the fish screen/through-screen velocity distribution control assembly, pump chamber head loss, head losses in the fishwater supply conduit, and the requirement for a 4.0-ft differential for supplied water (above tailwater) were summed to determine a required TDH of approximately 7.7 feet. This compares to the approximately 4.5-ft of TDH supplied by the present pumps. Note that in final design, fish screen (with velocity distribution control) and pump receiving chamber alternatives should be explored that reduce head losses and thus reduce TDH that must be supplied by the pumps. These efforts might include physical modeling of the screen and its associated velocity distribution control features.

Given the four pump configuration and a required pump capacity of 212.5 cfs per pump (with associated minimum pump bell and a minimum pump throat diameters), pumps could be selected that would supply the required discharge and TDH. Pumps of this size and capacity are commercially available (MWI/Couch offers a pump with a pump bell diameter of 90 inches and a pump throat diameter of 60 inches that will supply 220 cfs with 7.5 feet TDH - driven by a 300 HP motor).

d. <u>Fishway Water Supply Conduit:</u>

With emergency operation, 275 cfs out of the total 850 cfs supplied to the North Shore Fishwater Supply Conduit would be routed to

Diffuser 12 where it would supply flow to the North Shore Fishway and North Shore Fishway entrance. The remainder of the pump supplied flow (575 cfs) would pass down the supply conduit to the turbine-pump discharge chamber where it would be distributed. The flow rate supplied to Diffuser 12 would be controlled by the sluice gates at the diffuser. These gates have been removed and consequently would have to be reinstalled. If gates are reinstalled, enlarging the gates from the original 3-ft by 4-ft size should be considered in an effort to reduce associated head losses. A flow meter, that would be used to guide sluice gate setting, could be included in the supply conduit. However, the sluice gates could be opened to a specific field calibrated set-point with no further adjustment of the gate setting as tailwater elevation varies. This alternative was selected and a flow meter was not included in the proposed design.

The presence of the two 12-ft by 8-ft openings in the wall of the supply conduit will generate additional head loss during normal AWS operation. However because of the relatively low velocities in the conduit (1.65 ft/s), head losses generated by the two openings are small. Added loss is estimated to be 0.04-ft.

4.5.2.3 Mechanical

a. Pumps:

The pumping equipment depicted in the drawings for Alternative 2 consist of four 223 cfs (100,000 gpm) axial flow pumps configured with the pump components (60-inch propellers, guide vanes, bearings, etc.) located at depth in the pump sump. They are supported along the vertical discharge pipe and at the discharge flange at the horizontal discharge. The pump is driven through a vertical head shaft inside a column extension which is connected to a right angle gear drive at the tailrace deck level. The driver for each pump is a single 300 hp electric motor mounted on the pump station deck. The axial flow pump configuration with driver at the deck level was chosen due to its similarity to other pumping systems at the project and ease of maintenance of the driver and gear box.

The pump units would be maintained by unbolting the gear drive support at the deck level, removing the head shaft, unbolting the lower pumping units at the discharge flange and at the horizontal support (using divers), and extraction of the lower pumping unit by cranes. Maintenance of the pumps, although somewhat cumbersome and time consuming due to the underwater work, is not expected to be extensive due to their relatively infrequent usage as emergency equipment.

A number of other pumping equipment arrangements were considered and may be applicable to this pump station depending on the comfort level of the operators in using and maintaining them. These include submersible pumps where the all the pumping equipment including the electric motor are located underwater in a sealed unit, and hydraulic pumping units where the pump is driven by an electrically driven hydraulic system located on the pump station deck and connected to the pump by hydraulic hoses. Vegetable oils are used in the latter system to guard against environmental concerns. Costs for the hydraulically driven systems (Hydraflo as manufactured by MWI/Couch) are very competitive with the axial flow system selected. Like the selected configuration, underwater work would be required to remove the pump units for both the submersible and hydraulic systems.

The pumps would be fitted with vaned baskets to improve flow approach to the pumps given the very short pump intake. The baskets would be attached to the intake bells of the pumps or could be supported by the steel floor of the intake and compression-fit to the intake bells.

b. Water Control Gates and Bulkheads:

Pump Backflow Gates: Backflow prevention through the pumps to prevent backspin is important when the pumps are not being operated, which is a majority of the time. This is necessary since the water level inside the new pump chambers will reflect the normal operational head in the auxiliary water system because the pump station is not isolated from the rest of the system. The configuration depicted on the drawings shows flap gates installed on the pump discharges. Flap gates are optional features supplied by the pump manufacturers and are effective, simple devices. Other means of accomplishing this are to install sluice gates, valves, or bulkhead gates in front of the discharges. These would have to be manually (or automatically) deployed when the pumps are shut off. The flap gate is a gravity device and works like a check valve, deploying automatically when flow is interrupted. Four such gates would be required, one for each of the pumps.

Fishwater Conduit Isolation Bulkheads: Isolating the pump chamber (and tailrace) from the North Shore Fishwater Supply Conduit is required when the conduit is dewatered for inspection and maintenance. The bulkhead gates depicted covering the two new 12-foot by 8-foot openings in the wall of the conduit would be deployed under those rare circumstances and would be designed for full flood tailwater. Guide rails comprised of structural shapes bolted to the face of the concrete structure would allow the gates to be deployed over the opening. The gates would be comprised of structural shapes with a steel skin plate. Rubber bulb seals would seal the structure under seating heads of as much as 56 feet of water. While actual operation of the system should result in no unseating heads at the gates since the gate is not intended to be used to isolate the AWS from the tailrace when the AWS is operating under normal conditions (using the main AWS pumps), a minor amount of unseating head equal to the head of the AWS system should be designed into the gate and rails to guard against accidental deployment during normal AWS operations. To this end, a head of approximately 4 feet of water would be the appropriate unseating head.

Draft Tube Bulkhead Opening Slot Plugs: To prevent flow of water down through the bulkhead gate slot openings at the bottom of the new pump chambers, two removable steel slot plugs (one for each chamber) would be needed. These plugs would fit over and seal the openings. Deployment and retrieval of these plugs would be accomplished in the same manner as the bulkhead gates. Lifting eyes would be included on the slot plug that match the lifting beam for the bulkhead gate. Because the lift beam tracks down the slot inside the same guides used for the bulkheads, deployment of the plugs should be as predictable as the existing bulkhead gates. The slot plugs can also be deployed when the bulkhead gates are installed enabling the use of the pump station even when the draft tube is bulkheaded. Because the finish of the concrete is unpredictable at the sealing surface at the slot plugs, resilient rubber seals would likely be necessary to keep any leakage to a minimum. More drastic measures, including steel sealing surfaces constructed at the opening may be required to provide the desired seal.

Diffuser No. 12 Control Gates: As was noted above in Section 4.5.2.2, flow routed into the North Shore Fishwater Supply Conduit will travel to both the main AWS pump chamber as well as to Diffuser No. 12. Control of flow into Diffuser No. 12 is required in this alternative since the entire 850 cfs from the pump station is being routed into the conduit, thereby forcing more flow than was originally designed to be routed to the diffuser. Consequently, this flow must be regulated. During relatively recent modifications undertaken to improve the hydraulic efficiency of the flow to Diffuser No. 12, the original control gates (two 3-foot wide by 4-foot sluice gates) were removed. Consequently, these gates must be replaced. It is proposed, however, that the gate openings be enlarged and larger gates installed to improve the hydraulic efficiency of the original openings. Two new 4-foot x 4-foot gates would replace the original gates. This oversize of gates should allow for adequate hydraulic efficiency for the gates. A modest amount of concrete removal would be required to enlarge the gate openings.

c. <u>Fish Screens and Screen Cleaning Systems:</u>

Because the pumps could potentially entrain fish and debris if not fitted with screens, a series of removable fish screen panels are provided in front of the pump intakes. The various options for types of fish screens and cleaning systems are briefly described in Section 4.4.2.3. It was noted that in the absence of flushing or sweeping velocities, traveling screens are an appropriate screen system. At the turbine discharge draft tubes where these screens would be located, however, there is substantial turbulent flow which can be used to extricate material from screens as they are being brushed. Thus, static screens with vertically moving brush cleaners are recommended for this installation.

Vertical brush cleaning systems have horizontally oriented brushes moving up and/or down along the face of the screen. Motion is often achieved by pulling the brush with cables or chains along tracks. The sliding contact of the bristles with the screen and the vortices created dislodges debris. The extended length submerged bar screens (ESBS) in use at many of the Corps projects on the Snake and Columbia Rivers (including Lower Granite) utilize this type of vertically sweeping brush cleaner. For these structures, the bar sweeps vertically along the face of the screen and is driven by a chain drive system recessed in the support structure on either side. Specific advantages of this type of system include the virtually unlimited depth to which these systems could be designed. Stacks of screen panels each fitted with a single vertically sweeping brush bar would be developed for these fish screens. The cleaner would clean in an upward direction pushing material up to where the sweeping velocities in the tailrace would carry the material away from the screen face. A cam or linkage type mechanism would hold the bristles against the screen during the upward movement, and hold the bristles away from the screen during downward travel. To cover the full length of a fish screen at the intakes, a series of these cleaners would be employed, each dedicated to a single screen panel stack. The stored position of the vertical brush cleaner would be at the bottom of the screen panels either directly in the flow path or in a shielded enclosure. The removable screen panel design proposed for the pump station could be modified to enable the entire mechanical system for the cleaners to be removed for maintenance or inspection along with the stack of screens. This would reduce the maintenance aspects of the screen cleaner system as the components would be then above the water surface.

The bar screen material on the face of the screen panels would be a conventional stainless steel wedge-wire or profile bar sized per NMFS fry criteria. The screen panel structure, constructed of structural steel shapes, would have a porosity control element such as perforated plate on the downstream side. As was noted earlier, the porosity of the perforated plates would be determined through model testing to achieve uniform distribution of flow across the screens.

To guard against damage to the screens due to plugging caused by failure of the cleaners or excessive debris, an annunciation system of some type should be included in the design. It is proposed that the water level in the tailrace and immediately inside of the screens be monitored by an ultrasonic water level monitoring device to alert operators of a plugged screen condition.

4.5.2.4 Structural

a. Dam Stability Issues:

Dam stability as related to the new pump station relates to whether the modifications negatively impact the stability of the powerhouse structure. A review of the powerhouse stability diagrams for Generator Bays 1-5 shows that the maximum foundation pressures are well below the allowable bearing stress of the foundation rock. Contributions from the added weight of the water in the new pump well are approximately 250 kips (an increase of less than 0.3 percent in the powerhouse monolith water weight). Contributions from the added weight of the steel from the structure are approximately 750 kips (an increase in powerhouse monolith weight of slightly greater than 0.3 percent). Neither will have a significant impact on the stability of the powerhouse given the small increase in total mass, low horizontal center of mass relative to the base, and applied vertical loads in close proximity to the resultant of forces.

b. Pump Station:

The pump station design is proposed as two modular steel structures housing two pumps per structure that can be fabricated off-site and installed at the project through the use of divers. Because of the likelihood that the existing concrete structure will have some variability in its dimension and finish, it is unlikely that a single module steel assembly could be installed at once. Rather, subassemblies could be installed with final bolting accomplished underwater. The structures would be bolted to the downstream face of the piers at Unit No. 2 above the turbine draft tube discharge. One advantage of a steel structure is that no dewatering of the tailrace would be required (if it were even possible) except locally at the new concrete wall penetrations (see discussions below).

The basic concept for the pump structures is to create a pump discharge chamber between a new steel wall and the existing downstream face of the powerhouse into which the new pumps would discharge. To create this pump chamber, the new steel wall would span about 41.5 feet between the existing piers in a horizontal direction. The main horizontal beams would thus be designed for the hydrostatic pressure inside the pump chambers plus seismic including Westergaard loadings. The horizontally spanning walls would tie back to the pier noses with short walls that would be bolted to the face of the piers creating a horizontal frame. A wall load of approximately 16 kips per vertical foot would be transferred to concrete anchors (rock bolts) installed in the mass concrete of the powerhouse piers in discrete locations through anchor plates. All anchor installation would be done with divers. Final attachment would also be accomplished with divers. The wall, effectively a large vertical shear panel, would also take most of the vertical loading back to the piers. The steel floor panels at El. 485.0 ft. and El 516.0 ft. would act as deep beams adding stiffness to bottom of the wall panel contributing to a very stiff structural system resulting in very minor horizontal and vertical deflections. Support for the floor panel is shared between the vertical wall panel and the large concrete beam above the turbine discharge.

A latticework of tension bracing is provided at the downstream face of the structure. This bracing provides lateral support to the trashrack guides. If predation in the large open areas is a concern, the entire structure could be enclosed with a stiffened panel system rather than the bracing. Only light panels would be required because negligible differential loading would occur. Sufficient flow-through sections would be provided to ensure an exchange of water through the structure.

Because the steel structures supports large rotating equipment (the pumps and pump motors), a complete dynamic analysis of the structures would be required to confirm that the frequency of the equipment is not close to that of the structures. Typically, the natural frequency of the structures should be 25 percent greater than or less than that of the rotating equipment to ensure that detrimental vibration problems are not present. This dynamic analysis has not been performed at this time but would be required during final design. Portions of the steel framing supporting the motors and gear drives at the deck platform should be made removable to accommodate the removal of the pumps.

Installation of the pump station structures would have to be performed with the unit (Unit No. 2) and adjacent units (Units No. 1 and 3) off line due to safety concerns for the divers as well as to minimize turbulence in the tailrace which would make critical alignment and installation activities difficult.

The coating system for the steel structure is proposed to be a metallized coating as described in Section 4.4.2.4.

c. Concrete Removal:

It is necessary to remove concrete in two locations to allow flow from the pump station to flow to the auxiliary water system. Two 12-foot wide by 8-foot tall openings in the existing 2.5-foot thick concrete walls would have to be cut at approximately El. 490.75 ft. (bottom of opening). A dewatering cell on the tailrace side of the wall would be required to perform this work although the actual work face is assumed to be the inside of the 9.5-foot tall by 17.5-foot wide conduit. Diamond wire sawing is assumed to create the cut. Small pieces would be extracted and mucked out through the conduit. Because the wall is structurally framed by the structural slab above and the mass concrete below, no significant impact on the concrete structure is anticipated. A complete review of the structure should be performed during final design.

A modest amount of concrete removal would also be required to enlarge the existing two 3-foot wide x 4-foot tall control gate openings to 4-foot square at Diffuser No. 12.

4.5.2.5 Electrical

a. System Loads:

The tailrace-located pumping station will consist of four pumps, each driven by a single 300 hp electric motor. Minor amounts of additional power will be required for instrumentation, small motor and control loads, as well as lighting. A small step down transformer and distribution panel will provide local low voltage power for the pump auxiliary systems. Instrumentation and control wiring will be brought from the pump control center and connected to the plant control system. Two new 5 kv circuit breakers will be added as an extension to the existing station service switchgear. This scheme will be able to derive its power from the existing station service busses by adding 1200 kVA to a spare capacity of 2056 kVA. The uneven distribution of station service loads eliminates the possibility of connecting all pumps to a single bus. Bus 1 has spare capacity of 878 kVA, which allows a two motor capacity, and Bus 2 has 1181 kVA, which is approximately a three motor capacity. Therefore the scheme will permanently connect two pumps to each bus.

There are disadvantages associated with permanently connecting the motors to the two busses, but there is not sufficient capacity in the current station service equipment to operate all of the pumps simultaneously from the same bus. The costs associated with a capacity upgrade of the existing station service equipment would be very prohibitive. However the probability of one bus being inoperable for any extended period of time (longer than 24 hours) concurrent with a failure of a turbine pump is very unlikely. In order to ensure higher reliability, the pumps would be capable of being powered from a portable generator.

b. Power Supply and Routing:

This scheme will require two new 5 kV circuits, one from each of the two station service busses. Two outdoor 5 kV motor control centers will be mounted to the deck of each section of the pump structure. A separate compartment will house the control system, the low-voltage distribution panel, and the power transformer.

High voltage power conductors will be carried from the new circuit breakers in the station service switchgear, though the existing high voltage cable tray, to the vicinity of the new pumping station. The control wiring would also use the existing cable tray within the powerhouse. New power and control conduit will have to be brought through the powerhouse wall and under the tailrace deck to the new motor control centers.

4.5.3 Estimated Construction Costs

The following table presents the estimated construction costs for Alternative 2. Detailed cost information for Little Goose EAWS system alternatives is provided in Appendix C.

DIRECT CONSTRUCTION COSTS	**$5,240,860**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$262,043
General Contractors Overhead and Profit (26.5%)	$1,458,269
CONSTRUCTION SUBTOTAL	$6,961,172
Construction Contingency (25%)	$1,740,293
TOTAL CONSTRUCTION COSTS	**$8,701,465**
PLANNING AND ENGINEERING (22.5%)	$1,957,830
CONSTRUCTION MANAGEMENT (12.5%)	$1,087,683
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$11,746,978**

4.5.4 Conclusion

The following section discusses how Alternative 2 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: Like Alternative 1, Alternative 2 accomplishes the goal of providing one-pump "spare" or emergency flow capacity to the auxiliary water system. Unlike Alternative 1, flow is delivered to the North Shore Fishwater conduit rather than directly to the AWS pump chamber. From the delivery point, about 30% of the flow is directed to Diffuser No. 12 and about 70% to the AWS pump chamber. Being that the delivery point is very close to the pump chamber, functionally and operationally, it is quite similar in that regard to Alternative 1. Thus, the inherently greater flexibility afforded by supplying water (almost directly) to the pump chamber is also found in Alternative 2.

Like Alternative 1, the system can be brought on line in a relatively short period of time with the greatest amount of time likely to be associated with the bulkheading of the failed pump. The actual startup time associated with Alternative 2 is likely to be shorter than Alternative 1 since the pump station is already hydraulically connected to the AWS system. Thus, no sluice gates or sleeve valves need be opened since the flap gates on the pump discharges open automatically upon pump startup. The only gate adjustments would occur at Diffuser No. 12 where the gates would be throttled down to a pre-determined position. Once the fish screens at the new pump station are confirmed to be free of any accumulated debris (like Alternative 1), it is simply a matter of turning on the pumps.

Design and Construction Issues: Like Alternative 1, Alternative 2 is a fairly straightforward design although the pump station structure is seen to be a more complex structure than found on Alternative 1. The pump station, a steel structure, will require careful design attention to vibration issues to guard against resonance problems with the pumps. This analysis was not performed on the structure depicted on the sketches for this alternative. The development of the screening system is also seen as being more complex and potentially problematic than for Alternative 1 where a vendor-supplied screen system is procured and installed. For this alternative, the proposed brush bar system would require design development and testing to confirm its performance characteristics. With examples of this type of system already in operation at other facilities, some of this development work has already been performed. Yet, it is not as "clean" as the traveling screen design.

The system components should have a relatively long life. The fish screen cleaning system will require periodic replacement of components, especially the brush bar and drive chain assemblies. The pumps are proven designs with good long-term performance characteristics. The proposed metallized coating system for the underwater steel structures, which are not removable, should perform well and give excellent durability.

The construction complexity for this alternative is comparable to that of Alternative 1 except that the underwater installation of the pump station in the tailrace will require more diligence and care. This is primarily due to the fact that the proposed design requires careful (and fairly extensive) underwater drilling and bolting to the existing concrete piers on the downstream face of the dam in the tailrace which is inherently a turbulent area even with adjacent units off-line for construction. Also, large pre-assembled sections of the structure will have to be bolted together underwater. The turbulent nature of the tailrace will not make this any easier. The final installation and alignment of the pumping equipment will require close attention to fabrication and installation tolerances and a method of making modest adjustments to the pump supports underwater during final installation. Installation of the bulkhead gates and gate guide system will also require diver-assisted construction. Again, careful alignment of components underwater will be required for proper performance of this system. The concrete removal effort can be accomplished in the dry through use of a dewatering bulkhead and should be straightforward except for the mucking out of debris which will have to be transported through the conduit to an access hatch in the deck.

Construction of Alternative 2 will have greater impacts on the operations of the dam than Alternative 1. During the critical installation of the pump structure, at least three turbine units (Units 1, 2 and 3) will have to be shut down to allow installation of the underwater components. This is required both for diver safety and to make it possible to align and install large components accurately. It is expected that some disruption of the tailrace deck area near Unit 2 will occur with large cranes blocking (or partially blocking) access to the deck area during installation of the structures. At times, this blockage could be extensive. Close coordination with dam operations will be required.

Impacts to the normal operations of the AWS system during construction should be minimal. The work required to remove concrete and install the bulkhead gates (to allow the system to be brought back on line as the other construction progresses), should be able to be accomplished during the normal fish ladder/AWS maintenance window. All other construction activities are separate from the AWS system.

<u>Operations and Maintenance Issues:</u> The systems associated with Alternative 2 should be quite compatible with current dam operations. Operation of the pump station does require blockage of the draft tube bulkhead slot opening just above the draft tubes. Thus, if the bulkhead gates for the draft tube at Unit 2 need to be deployed (and then subsequently removed) the pump station will have to be shut down and the new slot plug removed. This slot plug is designed to be manipulated by the same crane and lift beam used for the bulkhead gates. This procedure will also impact the AWS system since it will have to be shut down while bulkhead gate installation takes place since the system is assumed to always be hydraulically connected to the pump station.

The pumping components of the system represent known technologies with proven reliabilities. The screen cleaning systems should be quite reliable, although these would be new designs for a new installation and the reliability of the system will be proven over time. The screen system is not seen to be as reliable as the traveling screen system in Alternative 1.

Given the benign nature of the operation of the screen cleaners and pumps (turn them on and let them run), the operability of the system should be quite straightforward and should have minimal impacts on the day-to-day operations of the dam. Given the fact that the system is designed specifically for emergency conditions, operational impacts of the system are even further reduced.

The fish screen system will likely require the most maintenance of any of the components of the EAWS. It is anticipated that periodic inspection of the screen panels for damage and the brush bars and drive system for wear will be required. The screen and brush bars can be removed or lifted clear of the water surface for maintenance, however, the cleaner drive system mechanisms will require diver inspection unless a removable cleaner system is designed. Like Alternative 1, given the anticipated low usage of the system, the greater risk is likely to be lack of use. Periodically, the equipment should be run and inspected to ensure that it is available when it is needed. If used for more extended operation (example, used as a flow supplementation system), more maintenance would be expected than in its designed role as an emergency water supply system. Either role would appear to be feasible. Maintenance of the pump components below the water surface will require the pump to be unbolted (by divers) and lifted out by crane. Since the gear boxes and prime movers are conveniently located on the pump platform, these items are readily accessible for maintenance.

Construction and O&M Costs: The estimated construction costs for this alternative are presented in Section 4.5.3 and compared to the other comparable alternatives at Little Goose (Alternatives 1, 3 and 5), are second highest behind Alternative 3.

The daily maintenance costs for this alternative are expected to be higher than Alternative 1, which has only fish screens, and higher than those for Alternative 5 which only has pumps but no screens to maintain. From a long-term maintenance standpoint, the relatively high cost of the pumping equipment (and more expensive maintenance thereof) certainly makes this a less attractive alternative than the more simplistic gravity option for Alternative 1. The Corps is familiar with and accustomed to large pumping stations, however, and maintenance is not seen as a serious issue. Certainly, the O&M cost projections for the plant will need to be adjusted for this additional maintenance.

As was noted in the discussions for Alternative 1, the cost of operating the EAWS system must include the energy costs. These compare very favorably to the value of the energy lost for Alternative 1 ($10,000 per year for the assumed month-long use of the EAWS compared to over $100,000 per year for Alternative 1 assuming $17.45 per MW hour). If the use of the system is expanded to provide a source of supplemental flow for the AWS system, the cost of operating the system will obviously increase. As was noted earlier, during periods when the hydraulically capacity of the project is exceeded, the "cost" of the water for Alternative 1 is effectively "free" and would compare very favorably to the cost for pumping for Alternative 2.

Other Issues: Use of Alternative 2 as a supplemental flow system to the AWS system (not its intended design use) is considerably more problematic than for Alternative 1. Since pump discharge is related to pumped head, and since increasing the total discharge of the fishway will likely involve increasing the head on the total system, the ability of this system, as designed for the EAWS, to provide supplemental flow to the existing system is questionable. Should Alternative 2 be intended as a flow supplementation facility to the AWS, the design would have to be reviewed in its entirety since additional pumping head will put additional loads on the structure and pumps.

Conclusions: Alternative 2 is a very viable alternative. It represents a less extensive construction effort than that proposed for Alternative 1; however, the construction effort is seen as being more complex. Likewise, the design is more complex with more mechanical systems. It has good flexibility in operation, reasonable constructability, good O&M characteristics, but a cost that is quite high compared to the other alternatives although not as high as Alternative 3. It has the added benefit of being less expensive to operate in terms of energy costs than Alternative 1 and in that regard, is more comparable to Alternatives 3 and 5. In its current design, it is seen as being less adaptable as a supplemental flow source for non-EAWS uses.

4.6 ALTERNATIVE 3 - AWS PUMPING EQUIPMENT UPGRADE

4.6.1 General Discussion

Alternative 3 – AWS Pumping Equipment Upgrade, was not considered in the Phase I report. This alternative was developed based on a recent Value Engineering (VE) study performed for modifications to the EAWS at Lower Monumental and Ice Harbor [6]. One of the accepted recommendations from that study was a proposal to replace the three existing water turbine-driven pumps at Lower Monumental with three larger electric motor-driven pumps such that two new pumps would have the same capacity as the three original pumps. This configuration would result in only two of the three new pumps being used for normal AWS operations with the third pump being reserved for emergency duties in case of a failure of one of the other two pumps. As a follow-up to the VE study, the COE has expanded the investigation of this proposal to determine its feasibility. Since the AWS pumping configuration at Little Goose is very similar (or nearly identical) to that at Lower Monumental, the COE recommended that this report address this concept for applicability and feasibility at Little Goose. It should be noted that replacement pumps at Lower Monumental were sized to provide a total of 2,100 cfs with two pumps operating. Little Goose pumps must be sized to provide 2,550 cfs to conform to the original AWS design parameters.

Alternative 3 in this Phase II report adapts the effort at Lower Monumental to Little Goose. Unlike the investigation effort at Lower Monumental, which is a final design effort and which has been tasked with extensive pump vendor contacts and hydraulic model studies, etc., the review of this concept for Little Goose has been conducted in a more cursory manner, consistent with a Phase II report. This is possible because of the similarities of the projects with regard to the AWS pumping configurations as well as other major related features. It is also necessary because the much broader scope of this report and the necessarily more restricted resources available with which to make a more detailed investigation. Consequently, only a single vendor has been contacted to confirm equipment specifics, and detailed hydraulic investigations have not been conducted.

4.6.2 Design Development Criteria

The following criteria were used for design development of Alternative 3 system improvements for the AWS pumping equipment:

- The upgrade should provide a total capacity to meet FPP requirements with two of the three pumps operating. (One pump out of service or on standby).
- Consider adapting the existing turbine penstock system into the new system to provide water for reducing required pump flow, if feasible.
- The present AWS design pumping capacity of 2,550 cfs will be provided as a minimum.
- Introduce flow to the turbine-pump discharge chamber/attraction water system in a manner that sustains effective flow distribution.
- Operation of the emergency water supply should be accomplished with a minimum of system configuration changes during the transition from normal to emergency operations.
- The effect of the increased electrical load from the new electric pumps to the 5-kV station service system should be evaluated.

The following criteria were used for design development for the modification of the turbine conduit to supply a gravity supplement:

- Maintain positive pressures throughout the supply system to prevent development of cavitation and release of free air.
- Over normal operating ranges maintain positive flow control at a single location in the supply line (avoid shifting control).
- Where possible, design the system to use existing conduits and butterfly valves.
- When operating over normal operating ranges, butterfly valves used for flow adjustment should operate with blades positioned in a responsive zone (blade angle of 25 to 55 degrees with 0 degrees being full open).
- Minimize the complexity and size of transport and energy dissipation structures.

4.6.3 New System Description

The following is a description of the major features and design considerations for development of the pump system upgrade. Proposed modifications are depicted on Plates 1.3.1 through 1.3.3.

4.6.3.1 General

The upgrade of the existing water turbine-driven AWS pumps to larger, electric motor-driven pumps involves very nearly the complete removal of all the pumping-related equipment in the AWS system pump house. Namely, the existing turbines, right-angle speed reducers, shafting, pump rotating parts and lower casing, turbine discharge pipe and associated auxiliaries would be removed. Moreover, all of the secondary concrete (grout) around the pump casing as well as the discharge elbow would need to be removed to allow removal of the existing equipment and to accommodate the larger propeller blades of the new pumps. The discharge elbow must then be reconstructed.

New vertical parallel shaft speed reducers, vertical electric motors, pump rotating parts and lower casings and associated auxiliaries would be installed. Vertical parallel shaft speed reducers with vertical motors were selected because of their simplicity compared to right angle speed reducers, lower cost, and simpler alignment procedures. If an option using penstock system water were adopted, a penstock control valve, energy dissipation diffuser and connecting piping would also be required. New 5 kv electrical service would be routed to the pump room from two new 2500 kVA substations. The substations would be located on the intake deck.

To deal with the additional motor heat loads in the pump room, additional cooling would be required. Sound attenuation enclosures at the pumps and motors may be desired, similar to the pump room configuration at Lower Granite which has similarly sized pumps and motors. However, because the vertical motor configuration proposed in this design results in an installation that is quite tall, sound attenuation would not be as straightforward as at Lower Granite.

The operation of the Alternative 3 system is as follows:

- Upon failure of one of the two operating AWS pumps (note that one of the three pumps does not normally operate and functions as a spare), all of the AWS pumps are shut down and the pump bulkhead for the failed pump is placed in its appropriate slot while the bulkhead for the spare pump is removed. After placement and removal of bulkheads, the two remaining operable pumps are started.

In developing Alternative 3, two pump configuration options were developed based on the criteria noted above:

<u>Option 1:</u> Supply the original AWS rated design capacity of 2,550 cfs with two pumps. Provide one spare pump. Three pumps rated at 1,275 cfs would be required. At 4 feet of static lift, motors would be approximately 1,100 hp each.

This option would ensure original design capacity, which may allow all FPP criteria to be met. Required discharge should be confirmed by a hydraulic study of the fish attraction system.

<u>Option 2:</u> Supply the original AWS rated design capacity of 2,550 cfs with the combined use of two of three pumps and the addition of 260 cfs flow by modifying the existing penstock system to discharge directly to the pump chamber. Three pumps rated at 1145 cfs each would be required. At 4 feet of static lift, motors would be approximately 1,000 hp each. In addition, the penstock piping would be extended to the existing turbine discharge point and flow control valves and energy dissipating diffusers installed.

This option would ensure original design capacity which may allow all FPP criteria to be met. This would have to be confirmed by a hydraulic study of the fish attraction system. This option would add equipment (turbine penstock valves and diffusers) to the system.

4.6.3.2 Hydraulics

a. General Hydraulic Design Overview:

As was noted in earlier discussions, the basis for this review of an AWS pump upgrade at Little Goose is the ongoing work for a similar proposed upgrade at Lower Monumental. The two projects are nearly identical in terms of original construction configurations and relative tailwater and forebay water elevations as related to the AWS pumping system. Little Goose has a 2-foot greater submergence on the pumps, although the normal minimum and maximum tailwater fluctuations are 3.0 feet at both projects. In a side-by-side comparison of the water passages related to the AWS pumping system including the pump intakes, pump housing, and pump discharge chamber, concrete dimensions are identical. This makes for a convenient basis for comparison. In terms of applying Lower Monumental findings to Little Goose, critical issues related to installing larger pumps such as anticipating hydraulic performance can be applied directly. Hydraulic conditions beyond the immediate pump discharge chamber in the rest of the fishway system are less comparable and although are similar may influence required lift. Detailed hydraulic analysis of the fishway including model studies and anticipated fishway operation should be considered in a final design process to better establish required lift and determine the influence of alternative supplied flow rates.

Hydraulic design of the AWS Equipment Upgrade focused on developing modifications to the existing turbine conduit system (including butterfly valves) that would allow use of that system as a continuously operated gravity supply to the existing turbine-pump discharge chamber. Included in the analysis were consideration of flow control options and consideration of alternatives for introduction of the flow to the turbine–pump discharge chamber. Hydraulic issues associated with the upgrade of the AWS pumps including potential effects of introducing locally increased and varying magnitude flows to the turbine-pump chamber and its flow distribution characteristics, were also addressed. Hydraulic Designs were developed in compliance with Design Development Criteria as stated above in Section 4.6.2.

b. Upgraded AWS Pumps:

Relatively recent field hydraulic studies and ratings have been conducted on the existing AWS pumping system at Little Goose [5] as discussed in Section 4.2.2.1. These studies were conducted in part to determine flow rates supplied by the existing AWS pumps. Despite this, there is substantial uncertainty about current pump discharge capacity. Indications are that current system flow rates lie somewhere between 2,100 and 2,550 cfs (between 700 and 850 cfs per pump for each of the three pumps). As a consequence there is uncertainty regarding what discharge needs to be supplied by upgraded pumps if the objective is to replace flow in-kind. However, if current or better fishway operating conditions are to be maintained, it appears that a system flow rate of 2,550 cfs should be provided. Thus, for a system utilizing only two pumps to provide AWS system capacity, each of the two pumps would provide 1,275 cfs. The third (spare) pump would likewise be capable of supplying 1,275 cfs. A comprehensive field rating of the existing system should be considered prior to selecting a preferred option.

The hydraulic performance characteristics of the existing pump intake and pump discharge related to the addition of larger capacity pumps is a complex subject integrally related to the characteristics of the final pumping equipment selection. Moreover, the resolution of these issues is beyond the scope of this report. Because of the large capital investment required by installing larger pumps, the pump procurement process should require hydraulic model testing of the pumps and intake.

Flows introduced to the turbine-pump discharge chamber will be largely unchanged from existing conditions. However the flow will be introduced primarily at two, instead of three locations. The particular flow introduction location will vary with the pumps in use. It appears that there is enough control capability at discharge openings from the chamber to compensate for changes in chamber hydraulics. It is uncertain what influence changes in chamber hydraulics will have on flow distribution characteristics. There is however the potential that fishway sluice gate settings may have to be modified with changes in operating pumps.

c. Fishway Performance:

A detailed hydraulic analysis of fishway performance and the influence of increased flow rates has not been conducted. If a pump upgrade is pursued, it would be prudent to conduct a hydraulic analysis of the fishway system (coupled with a detailed field rating) to better establish discharge influences and clarify design objectives.

d. Former Turbine Penstock Discharge:

It is proposed in Option 2 that the former turbine penstock discharge be used as a continuously operated gravity supply to supplement the new larger pumps. This would require that the existing turbines with draft tube expansions be removed. They would be replaced by long radius bends, new control butterfly valves, and reducers to ported diffuser plates. The existing butterfly guard valves would be maintained as guard valves for the new system.

Design and operation of this system are similar to that of the butterfly valve-controlled design that was considered as an option to the sleeve valve design developed for Alternative 1 (the south non-overflow gravity system). Under normal operating conditions the ported plate diffuser would control the release to the pump discharge chamber. The differential across the ported diffuser would be approximately 40-ft of water. The perforated plate diffuser would also function to maintain back-pressure on the flow control butterfly valve to prevent cavitation of the valve. Head differentials across the butterfly valve would likely range from 24 to 32-ft which should be sufficient to adjust flows and compensate for variations in forebay and tailwater elevation.

Since the ported diffuser would be positioned approximately 10-ft upstream from the release point to the chamber, jets exiting the diffuser should be largely dissipated at the entrance to the chamber. Therefore, both discharge magnitudes and flow velocities release into the turbine-pump chamber would be comparable to those occurring with the existing system.

An alternative design would use sleeve valves to dissipate energy and control flow. Sleeve valve designs are available that accept the inflow at 90 degrees to the discharge orientation. These valves appear to be well suited for replacement of the existing turbines and draft tubes. Although likely to be quite serviceable, it is expected that cost of these valves is substantial. Ongoing contacts are being maintained with a vendor (Lindsey Fabricators/Hartman Sleeve Valves) to cost out this option.

4.6.3.3 Mechanical

a. Pumps:

Pumps would be vertical propeller types. Option 1 would consist of three 1,275 cfs pumps with 149.5-inch diameter impellers, operating at 64 rpm capable of a static lift of 4 feet. Option 2 would consist of three 1,145 cfs pumps with 141.5-inch impellers, operating at 72 rpm, capable of a static lift of 4 feet. These are preliminary sizing data provided by Ingersoll-Dresser Pumps. Size and speed would be optimized during final design.

Pumps would be specified with stainless steel impellers and water lubricated bearings. A thrust bearing mounted in the speed reducer would accommodate hydraulic thrust.

Pumps of this size, being installed in an existing inlet channel, should be model tested to verify operation.

b. Speed Reducers:

Speed reducers would be vertical, parallel shaft types. A service factor (safety factor) of at least 1.5 would be required. Auxiliaries would include sump heaters and water cooled oil heat exchangers. The reducers would incorporate a thrust bearing for the pump and motor and an anti-backspin device.

c. Motors:

Motors would be vertical, mounted on the speed reducer through a flexible coupling; 5kV, induction type with heaters. Enclosures would be drip-proof. Motor speed would be selected for the most economical combination of motor and speed reducer cost. Option 1 would require an 1,100 hp motor; Option 2 a 1,000 hp motor. Preliminary sizing is based on a 1,200 rpm nominal speed.

d. Penstock Piping:

Option 2 would make use of the existing penstock system to provide additional water to the AWS. Each of the existing turbines passes approximately 85 to 90 cfs to the pump discharge chamber. Maintaining the same flow would provide approximately 260 cfs additional flow beyond the pump capacities. Piping would be added to connect the present penstock termination to the present turbine draft tube discharge at the downstream wall. Energy dissipation would be by a stainless steel butterfly flow control valve, dissipating 1/3 of the 95 feet of head; with a stainless steel diffuser, located within the new piping, dissipating the remaining head.

4.6.3.4 Pump Room Modifications

a. Hoists and Structure:

The existing power house crane and fish pump trolley will be adequate to serve the new pumping equipment. A new structural support system will be required for the new pumping equipment. Supports can use the existing beam pockets.

b. Noise Control:

If a noise attenuation enclosures are desired at the pump motors, light, prefabricated systems can be installed in the ample areas surrounding the pumps. However, noise levels should be comparable to the existing turbine-driven pumps.

c. HVAC:

The motors will produce considerably more heat than the existing turbines. The existing ventilation system will be retained to provide outdoor air requirements and will be supplemented by installing two raw water cooled air conditioners, recirculating air within the space via a system of supply and return ductwork. Each unit will be rated for 13,000 cfm and require 28 gpm of raw water. Space temperature can be maintained at 95° F with raw water cooling. This would be sufficient for machinery spaces.

4.6.3.5 Electrical

a. System Loads:

This system will remove the existing turbine-driven pumps and replace them with new electric motor-driven pumps. The three new pumps will each require at least 1000 hp electric drive motors depending on the final pump selection. The new pumps will be installed in the existing pump room, and use vertically mounted motors with a parallel shaft gearboxes. Low voltage control power will be required for auxiliary systems such as oil heaters and circulation pumps for the gearboxes. Instrumentation and control wiring will be brought from the pump room to the plant control system through existing cable tray.

This scheme will place significant new load onto the present station service system. The current system can only accommodate one pump on station service Bus 2. There are several limiting factors with the current 5 kV buss system that would make it impractical to modify the system to handle the new motors. The primary limiting factor is the size of station service transformers, which are currently 2500 kVA. The new scheme will require at least 3000 kVA additional load on the station service system, with 2000 kVA being provided on a continuous basis. Therefore each bus would need to accommodate 2000 kVA in additional loads.

Even if the transformers were upgraded to 5000 kVA, the remainder of the station service system would require replacement to accommodate the additional capacity. The power cabling from the transformer to the switchgear will need to be replaced and the bus bar within the switchgear would be too small to handle to increased load. Replacement of the bus bar is very expensive. It would be less costly to replace the 5 kV station service switchgear. Equipment downstream from the switchgear would require little or no modifications.

A less expensive alternative to revisions to the existing switchgear would use two new power transformers installed on the upper deck of the powerhouse, each connected to separate sections of the station 13.8 kV bus. This would be similar to the existing station service arrangement. Each transformer would be 2500 kVA in size, large enough to power two pumps, and would have one pump permanently connected. The third pump would be allowed to alternate between the two busses, assuring adequate water under all conditions.

b. <u>Power Supply and Routing:</u>

The new transformers will be installed on the upper deck of the powerhouse, with high voltage fuses connecting them to a 13.8 kV bus extension. The 5 kV side of the transformer will be routed to a new current limiting reactor, surge arrestors, and then using existing cable tray, to two new 5 kV circuit breakers near the existing station service switchgear. The power cables will be routed from the switchgear through new cable tray and conduit to the pump room and connect to two of the three 5 kV motor starters and a 5 kV automatic transfer switch. The automatic transfer switch will be connected to one pump, which will be able to derive its power from either bus, assuring adequate water under all conditions. A similar method will be used for low voltage control power and instrumentation wiring, however the majority of this portion of the new system will be able to use existing wiring and conduit.

4.6.3.6 <u>Constructability</u>

Unlike the other alternatives, Alternative 3 requires the existing AWS pumps to be out of service while removing the existing pumps and installing the new pumps. Removal and installation of a pump will require three months. This assumes some two-shift and Saturday work. The normal maintenance period for the AWS is January and February – two months. In order to install a new pump, this period will have to be extended by one month. This will require prior agency agreements. Construction will extend over a three year period with one pump replaced each year.

Following is a proposed construction sequence:

- Before starting pump work, procure and install electrical upgrades and auxiliaries that do not affect the existing pumps.
- Procure and have the first pump on site.
- Prefabricate and have formwork for the new concrete pump casing and elbow on site.
- Remove first pump, turbine, speed reducer and second stage concrete.
- Install replacement pump stationary parts
- Form and pour new second stage concrete.
- Install replacement pump rotating parts, speed reducer and motor.
- Connect electrical feeder to motor.
- Test and startup replacement pump.

Repeat the process (except for the electrical upgrades) for the second and third pump in the following years. Construction costs for installing the second and third pumps have been escalated 4% per year to account for the extended construction period.

Interim first year operation with one large pump and two existing smaller pumps would require adjusting the wicket gates on the turbine-driven pumps to maintain the proper flows.

4.6.4 Estimated Construction Costs

The following table presents the estimated construction costs for Alternative 3. Detailed cost information for Little Goose EAWS system alternatives is provided in Appendix C.

In the development of construction costs for Alternative 3, it was determined that costs for Option 1 and Option 2 for Alternative 3 will be similar. Option 1 pump costs are higher than Option 2 due to the slightly large pumps, but Option 2 has penstock pipes sections and control valves associated with redirecting flow from the former turbine to the pump chamber. There are also considerations of lost revenue for bypass water not run through the main generating units associated with Option 2. Therefore, estimated construction costs were developed for Option 1 only.

DIRECT CONSTRUCTION COSTS	**$6,552,063**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$327,603
General Contractors Overhead and Profit (26.5%)	$1,823,111
CONSTRUCTION SUBTOTAL	$8,702,777
Construction Contingency (25%)	$2,175,694
TOTAL CONSTRUCTION COSTS	**$10,878,471**
PLANNING AND ENGINEERING (22.5%)	$2,447,656
CONSTRUCTION MANAGEMENT (12.5%)	$1,359,809
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$14,685,936**

4.6.5 Conclusion

The following section discusses how Alternative 3 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: Like Alternatives 1, 2 and 5, Alternative 3 accomplishes the goal of providing one-pump "spare" or emergency flow capacity to the auxiliary water system. Like Alternative 1, flow is delivered directly to the AWS pump discharge chamber where is can be used with the greatest degree of flexibility.

The "spare" third AWS pump (functioning as the EAWS) can be brought on line in a relatively short period of time with the greatest amount of time likely to be associated with removing and inserting the bulkheads. Startup will only require removing the bulkhead from the "spare" pump and installing the bulkhead in the failed pump. Then it is simply a matter of turning on the pump.

Design and Construction Issues: Alternative 3 is a fairly straightforward design using the intake and discharge water passages of the existing pumps. Increasing the pump flow from 850 cfs to 1275 cfs with the existing waterways increases both suction intake and discharge velocities by 140 percent. Velocity increases can have a detrimental effect on pump performance, especially pump suction conditions. However, with approximately 70 feet of submergence, the larger pumps should handle increases of this magnitude. It is recommended that the pump be model tested during the procurement process to verify satisfactory operation. Thus, one of the greatest design burdens will likely rest on the pump manufacturer to confirm the pump design for the new installation. By using the same water passages and intakes, additional screening for fish will not be required reducing the complexity of the design considerably.

The system components should have a relatively long life, as the pumps are slow speed. Parallel shaft speed reducers are more reliable than the existing right-angle units. The motors are of standard construction.

Using the existing waterways and blockouts, the construction is not very complex. However, the construction sequencing is. Because of the limited downtime allowed by the maintenance period, construction of this alternative will have to be spread over three years. Removal of an existing pump and installation of a new pump will take at least three months, requiring the present two-month fish passage system maintenance period to be extended an additional month barring any construction or system startup and testing delays. This will require agency approvals.

Some aspects of the installation that impact the construction time include removing all of the second stage concrete to install the larger pump, forming and reconstruction of new pump water passages and discharge elbows, then pouring new second stage concrete. Only after this work is completed can the mechanical installation take place. To minimize the construction period, pump parts would have to be on site and ready to go. Concrete forms for the pump water passages would have to be prefabricated and ready for installation in the blockout. After installation of the first pump, the process must be repeated in subsequent years for the remaining two pumps. The work area can be isolated from the tailrace by installing the pump intake bulkheads and dewatering the pump discharge chamber.

Alternative 3 will require extensive modification to the 5 kV station service system in that two new dedicated substations and extensive high voltage cabling will be required.

Construction of Alternative 3 will have moderate impact on the operations of the dam since most of the work is confined to the erection bay and for the most part, will take place during the normal maintenance periods. Addition of the electrical substations will require a short "cutover" shutdown of the dam's station service system. Storage space must be provided so pump parts can be pre-positioned on site before pump work begins

Impacts to the normal operations of AWS system during construction should be moderate since the work schedule would include the normal AWS maintenance period plus possibly a one-month extension.

Operations and Maintenance Issues: The systems associated with Alternative 3 should be quite compatible with current dam operations. The pumping components of the system represent known technologies with proven reliabilities. Electric motor drivers and parallel-shaft speed reducers require less maintenance than the present turbine drivers and right angle speed reducers. Also, being new equipment, downtime for minor auxiliaries failures will be greatly reduced.

Construction and O&M Costs: The estimated construction costs for this alternative are presented in Section 4.6.4 and compared to the other similar alternatives at Little Goose (Alternatives 1, 2 and 5), are considerably higher than the others.

The daily maintenance costs for this alternative are expected to be lower than the other alternatives. The other alternatives still retain the maintenance requirements of the existing turbine-driven pumps plus the maintenance required by the specific alternative. In fact, maintenance cost for this system may be lower than the present system since the electric motors will require less maintenance than the existing turbine-drive system.

With regards to energy costs, the higher energy consumption of the new electric motor drivers (versus the existing fish pump hydro-turbines) is offset by no longer needing to divert the 260 cfs of forebay water for the turbines since the fish pump turbines are removed in this alternative. The diverted water can thus be used for additional generation in the main units. It should be noted that as in Alternative 1 with its gravity intake, if the hydraulic capacity of the project has been exceeded (water is being spilled), this water is effectively "free" making this less of an advantage. For energy consumption calculation purposes, two electric motor-driven pumps require approximately 1730 kW of electrical power. The redirected 260 cfs of flow will generate approximately 1880 kW. Therefore, changing to electric pumps provides a 170 kW benefit worth $20,400 per year at $17.45 per MW hour [2]. Present value would be $237,300 (7% interest, 25-year period).

Other Issues: Use of Alternative 3 as a supplemental flow system to the AWS system (not its intended design use) would be possible to a limited extent by providing one of the pumps with a two-speed motor and running it at low speed in conjunction with the other two pumps at normal speed. The present discussion and cost estimates assumes only single speed pumps. Since pump discharge is related to pumped head, and since increasing the total discharge of the fishway will likely involve increasing the head on the total system, the ability of this system, as designed for the EAWS, to provide supplemental flow to the existing system is questionable. Should Alternative 3 be intended as a flow supplementation facility to the AWS, the design would have to be reviewed in its entirety since additional pumping head will put additional loads on the structure and pumps.

Conclusions: Because of its high initial costs, Alternative 3 is not a very viable alternative. This is especially true since the existing pump-turbine system is in relatively good condition and should provide many additional years of service. Installation of the new pumps represents a complex and multi-year construction effort. The design is also more complex. It has good O&M characteristics, and good O&M costs with some savings in energy costs over the turbine pumps. In its current design, it is seen as being less adaptable as a supplemental flow source for non-EAWS uses.

4.7 ALTERNATIVE 4 - ENHANCED MAINTENANCE AND EQUIPMENT RELIABILITY UPGRADES

4.7.1 Phase I – Technical Report Alternative Review

A program of enhanced maintenance was presented as Alternative 4 in the Phase I report. As was noted earlier in Section 4.3.1.4, a program of enhanced maintenance will not by itself satisfy the EAWS criteria established in Section 2.3. This is due to the fact that even with enhanced maintenance, the requirement for one-pump spare capacity cannot be met at Little Goose with the existing AWS pumping equipment. At best, it would decrease the downtime for minor auxiliary equipment failures. Major equipment failures, on the other hand, would result in a long-term period of inadequate flows for the AWS. In this Phase II report, the concept of enhanced maintenance will be investigated further and developed not as a stand-alone alternative, but rather as a supplemental alternative to Little Goose Alternatives 1, 2, and 5 which develop new sources of water to achieve the one-pump spare capacity.

Two types of enhancements will be considered: 1) Correction of known operating and maintenance problems to existing equipment, and 2) increased spare parts inventory to permit rapid correction of minor auxiliary equipment failures.

A third area mentioned in the Phase I report, a more aggressive operation and maintenance program, is not required. The maintenance staff is well aware of the importance to maintaining the AWS and repairs to the systems are a high priority. Preventive maintenance is also high with monthly, semiannual and annual programs in effect. Even if it were valid, this solution would probably be nearly impossible to implement considering present and expected future budget constraints on maintenance functions.

This alternative would be a responsibility of Project Operations and would require increased funding through the Operations and Maintenance Budget.

4.7.2 Design Development Criteria

The following criteria was used for design development of the enhanced maintenance and equipment reliability upgrades:

- Correct known problems causing lost time or service in the operation of the AWS system. Such problems either reduce reliability or cause the shutdown or startup of equipment to be excessively delayed.
- Recommend spare parts to maintain in inventory to permit repair of minor auxiliaries within a 24-hour period.

4.7.3 New System Description

The following is a description of the major features and design considerations for development of Alternative 4. Electrical system modifications are shown on Plate 1.4.1.

4.7.3.1 Mechanical

a. Correcting Known Problems:

Problem: The AWS pumps are difficult to start due to high oil viscosity in the speed reducers when the oil is cold. Operators have to go through several attempts until the oil is warm enough to allow the turbines to reach operating speed. This can take several hours.

Recommended Solution: The recommended solution is to install an oil heating circuit to circulate speed reducer oil through an electric heater when the pump unit is not running. The circuit would consist of a connection to the pressure oil pump suction line, a small (1 or 2 gpm) circulating pump, an in-line electric heater and discharge piping with filter terminating at the sump oil drain port. The heater would be thermostatically controlled.

This modification is applicable to any alternate that retains the existing pumps. New speed reducers provided under Alternate 3 would be procured with oil heaters.

b. Enhanced Mechanical Spare Parts Inventory:

This part of Alternative 4 would provide a stock of spare parts to permit rapid replacement of failed items, thus improving overall system reliability. The items listed in the following table covers longer lead purchased items. Common materials such as pipe, fittings, small hand valves, conduit and wire should be readily available at the plant or quickly procured from local sources. Sufficient quantities for one pump unit should be provided.

Speed Reducer Lub. Oil Pump	Pump Shaft Seal
Speed Reducer Thrust Bearing Oil Pump	Pump Bearing Set
Speed Reducer Oil Flow Switch	Turbine Wicket Gate Pins
Speed Reducer Temperature Transmitter	Turbine Wicket Gate Bushings
Speed reducer Water Flow Switch	Gateshaft Opr. Brake Shoes & Springs
Speed Reducer Temperature Relay	Gateshaft Opr. Gearmotor
Speed Reducer Gear and Shaft Set	Water Solenoid Valves
Speed Reducer Bearings	
Thrust Bearing Shoes, Set	

Recommended Spare Parts Inventory

There is a complete spare Philadelphia speed reducer on site. This will serve all three pumps. It is also shared with Lower Monumental. There is a complete spare turbine at Lower Monumental which can be used at Little Goose. Casting patterns for new runners are also stored at Lower Monumental.

4.7.3.2 Electrical

As was noted in Section 4.2.2.3, the electric wicket gate operators are susceptible to a single mode failure, in that there is only a single source of power for all three operators. Failure in the single source of power would leave the turbines inoperative for an extended period of time (longer than 24 hours). Alternate sources of power are available and should be connected to the turbine auxiliary systems through an automatic transfer switch. Although failure of the power system may be mitigated by a work-around plan, this is a vulnerability that should be rectified. Installation of an automatic transfer switch is the recommended solution. See Plate 1.4.1 for a one-line diagram for this improvement.

4.7.4 Estimated Construction and Expanded Parts Inventory Costs

The following table presents the estimated construction costs for Alternative 4. Detailed cost information for Little Goose EAWS system alternatives is provided in Appendix C.

DIRECT CONSTRUCTION COSTS	**$30,462**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$1,523
General Contractors Overhead and Profit (26.5%)	$8,476
CONSTRUCTION SUBTOTAL	**$40,461**
Construction Contingency (25%)	$10,115
TOTAL CONSTRUCTION COSTS	**$50,576**
PLANNING AND ENGINEERING (22.5%)	$11,380
CONSTRUCTION MANAGEMENT (12.5%)	$6,322
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$68,278**

The cost for procurement of the proposed expanded inventory of spare parts for the Little Goose AWS system is $148,140. Detailed cost information for the expanded parts inventory described in this alternative is provided with the construction cost estimate in Appendix C.

4.7.5 Conclusion

Alternative 4 does not meet the basic EAWS criteria of providing one-pump spare flow capacity. In that sense, this alternative cannot fulfill the needs of the project as a stand-alone EAWS alternative. What Alternative 4 does is provide an increased level of reliability to the existing AWS system. The proposed equipment reliability upgrades and the expanded inventory of critical spare parts would dramatically increase the reliability of the existing system. Thus, its merits as a complementary alternative to Alternatives 1, 2, and 5 are unquestioned. Since Alternative 3 replaces the existing AWS pump system with an entirely different system of pumps, and since Alternative 4 is specifically targeted to the existing AWS system, it is not applicable to Alternative 3.

4.8 ALTERNATIVE 5 – NEW PUMPED SUPPLY FROM THE TAILRACE AT THE EXISTING AWS PUMP INTAKES

4.8.1 Design Development Criteria

Alternative 5 proposes to install pumps in the roof of the existing AWS pump intake with flow from the pump being directed into the AWS system. In developing this pumped flow alternative, the following criteria were used for design development. These criteria are similar to those developed for Alternative 2, the other tailrace pumped alternative:

- The pump station should provide a minimum of 850 cfs additional emergency flow capacity to the auxiliary water system (one-pump equivalent capacity).
- The optimal location to introduce the new flow capacity, in order to be compatible with the existing hydraulic design of the fishway, would be at or near the pump discharge chamber near the existing AWS pumps in the Erection Bay.

- The new pump station location should not significantly affect plant operations.
- The pumps should be readily serviceable. If possible, pumping equipment should be serviceable without dewatering the pump sump.
- The existing intakes for the AWS pump system are to be utilized in this alternative.
- The hydraulic conditions at the pump intake should be appropriate to provide efficient, vibration-free pump operation.
- Operation of the emergency water supply should be accomplished with a minimum of system configuration changes during the transition from normal to emergency operations.
- Techniques for construction of the pump station structure should minimize dewatering during construction.
- The location and operation of the pump station should not negatively impact adult fish upstream passage.
- The pump station should not negatively impact AWS pump intake hydraulics.

The objective of this alternative, as noted earlier, is to construct new emergency pumping capacity by utilizing the same pump intake currently utilized by the existing three main fishwater pumps for the AWS system. Thus, a new intake structure would not need to be constructed in the tailrace. By reviewing the project drawings for the AWS system and the geometry of the intake structure, it is apparent that the only feasible way to add additional pumping capacity and utilize the existing intakes is to penetrate the 7-foot thick roof slab of the intake, place one or more pumps through the roof, and pump into the AWS system through the west wall of the concrete structure containing Diffusers No. 1 and 2. The pumps would be located immediately adjacent to this wall. Since the top of the intake roof is 45 feet below grade, some type of pump well or other structure would have to be constructed to accommodate the pumps.

4.8.2 New System Description

The following is a description of the major features and design considerations for development of the new pumping station. The new pump station is depicted on Plates 1.5.1 through 1.5.4.

4.8.2.1 General

In Alternative 5, a new emergency pumped supply is constructed utilizing the existing AWS pump intake. Three new submersible pumps are installed through three new openings created in the roof of the intake, one in each of the three water passages. A new pump well, partitioned into three separate wells, is constructed from the top of the roof at El. 513.0 ft. to the existing top of grade at El. 558.0 ft. One of the four sides of the new pump well makes use of the west wall of the existing structure. Water is pumped vertically into the pump wells and flows through new gated openings created in the west wall of the existing concrete structure. During operation of the EAWS system, the existing gated openings to Diffusers No. 1 and 2 would be closed, isolating these diffusers from the rest of the main AWS system. Flow from new pumps would be started, the new gates opened, and flow to Diffusers No. 1 and 2 would be restored, now using the new EAWS pumps. Approximately 665 cfs (333 cfs per pump) would be routed from EAWS Pumps No. 1 and 2, (the southernmost and middle pumps) to Diffuser No. 2. Approximately 205 cfs would be routed from EAWS Pump No. 3 (the northernmost pump) to Diffuser No. 1. These flows closely match the current flow distribution to these diffusers using the AWS pump system.

The operation of the Alternative 5 system is as follows:

- Upon failure of one of the three AWS pumps and identification of the need to operate the EAWS system, all of the AWS pumps are shut down and the bulkhead for the failed pump is placed in its appropriate slot.
- The existing water control gates for Diffusers No. 1 and 2 are closed.
- The new water control gates for Diffusers No. 1 and 2 (leading from the new pump chamber) are opened to a pre-determined setting.
- The new EAWS pumps as well as the remaining two operable AWS pumps are started.

Once the bulkheaded pump is repaired, the EAWS system is shut down in the reverse order indicated above.

4.8.2.2 Hydraulic/Fisheries

a. General Hydraulic Design Overview:

The hydraulic design of an emergency pump station that draws from the existing pump intakes focused on evaluating the influence of pump station operation on the existing intakes, evaluation of pump station hydraulic performance characteristics for determination of the required TDH, and evaluation of the compatibility of the emergency pump station supply with the existing diffuser/fishway supply conduit system. Hydraulic designs were developed in compliance with the Design Development Criteria as stated above (Section 4.8.1).

b. Influence on Existing Intakes:

The existing AWS pump intakes draw flow from the tailrace, through the trashrack and then through three conduits that are isolated from each other by walls. These conduits in turn supply flow to a common chamber which supplies all three turbine-pumps. The common chamber feature of the existing intake design will tend to uniformly distribute flow among the three conduits independent of the specific turbine-pumps that are in use. Since the EAWS station would be operated when a turbine-pump was down, and one of the EAWS pumps draws from each of the conduits, operation of the EAWS station will generally maintain existing velocities in the intake conduits and at the existing trashracks. As a consequence, influences of the EAWS system on the operational characteristics of the intake should be minimal.

c. Pump Station:

The EAWS pumps discharge flow vertically into up-wells. There is sufficient expansion in the up-well from the pump exit to largely dissipate the full pump exit velocity head. A gravity flow then passes through sluice gates and into a vertical conduit that feeds Diffusers 1 and 2. The sluice gates were sized and positioned to mimic the existing diffuser supply control gates. This was done in an effort to provide a velocity field approaching the diffuser intakes that is comparable to existing conditions. Based on a full velocity head loss in the up-well, a full velocity head loss in the vertical conduit (with a 0.6 gate coefficient), and an estimated required differential in the vertical conduit above tailwater of 2.0 ft; the smaller pump would have to supply a TDH of 6.9-ft and the larger pump would have to supply a TDH of 6.7-ft. This is within the capability of the proposed pumps.

Limited submergence is supplied above the sluice gates in the up-well. It is likely that air entraining vortices will form at this location. Most of the entrained air is expected to rise and vent from the vertical conduit. If vortex entrained air did prove to be a problem (for example due to bubbles venting through the diffuser), a retrofit vortex suppressor could easily be added to the up-well.

This analysis includes numerous simplifications and approximations that may significantly influence supply to the diffusers and thus diffuser performance. If this concept is further pursued it is recommended that a physical model study be used to refine and verify the design.

d. Fishway Water Supply Conduit Operations:

Operation and control options associated with the operation of Alternative 5 in combination with the remainder of the AWS system were reviewed. It was noted that unlike Alternative 2, the capability of effectively controlling flow rates supplied to Diffusers 1 and 2 while maintaining open conduits to the remainder of the AWS system is uncertain. Since the pump-supplied flow rate closely matches required flows for Diffusers 1 and 2, it appears that a more direct operation would be to isolate the Alternative 5 pump station and Diffusers 1 and 2 from the remainder of the system and operate them in isolation. This should minimize control changes required for the remainder of the system (when transitioning from normal to emergency operation) and thus would simplify that transition.

4.8.2.3 Mechanical

a. Pumps:

As was discussed above, the pumps for the new structure withdraw water from the existing AWS pump intake conduits and feed Diffusers No. 1 and 2 in the adjacent structure. To accomplish this, a number of strategies can be employed as was discussed above. Because of the configurational constraints of the facility, however, it was concluded that the most effective way to pump the water was vertically through the roof of the intake into a new pump chamber and then supply the diffuser by gravity flow through new openings in the west wall of the diffuser structure. These new openings are arranged to mimic the existing flow distribution method for the diffusers.

The pumps proposed to accomplish this are electric submersible pumps. These pumps, which are configured with the drive motor, gears, and propeller all contained within a sealed housing, are completely submerged in their installed position. The pumps would be provided with internal moisture and oil level sensors and alarms. Gears would be lubricated with an environmentally acceptable vegetable based oil. Submersible pumps typically operate at higher efficiencies than conventional lineshaft pumps and are more cost effective than other types of pumps due to more simplistic installation configurations.

Submersible pumps are installed in an encasing pipe. Pump radial alignment is maintained by guides and mating grooves. Vertical positioning is by pump weight and hydraulic thrust. Pump removal would be a straight lift by a mobile crane using a permanently attached cable. Installation requires aligning guides and grooves and lowering the pump. A diver may be required for guidance during initial insertion of the pump into the pipe. This will depend on how high the pipe extends. Once removed, maintenance is straightforward in the plant's shop.

Because the pump is not bolted down, the removal procedure is less complex and time consuming than lineshaft pumps. On the other hand, because the driver for lineshaft pumps is located above water, only work on the pump impellers, guides, and bearings would require removal of that type of pump whereas any work on the submersible would require complete removal of the pump. The structure required to accommodate the submersible pumps is less complex and extensive than it would likely be for lineshaft pumps (see discussion in following text).

Two pump sizes are proposed. The smaller pump, Pump No. 3, is rated at 92,000 gpm (205 cfs) and would feed Diffuser No. 1. This pump has a 300 hp, 1200 rpm electric motor with a 6.6:1 gear, a 60-inch propeller with a 90-inch intake and a 66-inch discharge. Weight of the pump is slightly over 12,000 lbs. The larger pumps, Pumps No. 1 and 2, are rated at 150,000 gpm (334 cfs) and feed Diffuser No. 2 from separate pump chambers. These pumps, also submersible, have 500 hp, 1200 rpm electric motors each with a 6.8:1 gear, 60-inch propeller with a 90-inch intake, and each with an 84-inch discharge. The weight of the larger pumps is 20,000 lbs.

The final selection of pumps, either submersible or lineshaft, may depend on the particular preference of the Corps. The design depicted could be modified to accommodate lineshaft pumps. The resulting structure would likely be more complex due to the need to support the pump at a higher elevation. Also, the pump discharges would have to be routed either directly through the wall, employing some type of baffling structure in the narrow 3-foot wide chamber, or into a new pump chamber within the new pump structure and then through the wall using sluice gates as shown on the proposed design. This would make the overall structure somewhat larger. The cost of the lineshaft pumps is also greater.

b. Water Control Gates:

Two 48-inch square and four 60-inch square gates are required for the pump station to control water flow through the west wall of the existing structure. Conventional medium duty sluice gates are proposed with stem extensions which allow the stems to rise but not protrude from the concrete deck and into traffic. A similar installation is employed at various other gate locations at the project. The gates would be designed for 30 feet of seating head and only 5 feet of unseating head since the pump chamber cannot be dewatered.

c. Debris Maintenance:

The trash racks at the AWS pump intakes, which provide debris control to the existing AWS pumps, will provide debris control for the new pumps since the water is withdrawn from the same supply conduits.

4.8.2.4 Structural

a. Dam Stability Issues:

Modifications related to the construction of the new pumping station at the AWS pump intake structure will have a negligible effect on the stability of the intake structure. The pump chamber is not designed to be dewatered; therefore, no additional uplift is experienced. The new concrete structure added to the intake will increase the overall weight of the structure but represents a relatively small increase in the total structure mass.

b. Pump Station:

The new pump station is designed as a reinforced concrete structure to be constructed adjacent to and on top of the existing AWS pump intake. The structure is divided into three hydraulically separate pump chambers into which the three new pumps discharge. The two chambers for the larger pumps are nominally 23 ft. long, 12 - 14 feet wide, and 45 feet tall. The chamber for the single smaller pump is almost 36 feet long, 12-14 feet wide and 45 feet tall. Three sides of the new structure are new cast-in-place concrete construction while the fourth side makes use of the west wall of the existing structure. The bottom of the structure is the roof of the AWS pump intake. Where new construction interfaces with existing concrete, the new reinforcing at the interface is drilled and grouted into the existing structure. The top of the structure is also cast-in-place concrete construction and is designed with three concrete access hatches located above the pumps. For water to enter the pump chamber, the 7-foot thick roof of the AWS pump intake is penetrated in three places with 96-inch diameter openings. These openings accommodate the pumps. For water to exit the chamber and feed Diffusers No. 1 and 2, the existing west wall is penetrated in six places with 4-foot and 5-foot square openings. Issues related to concrete removal are discussed later.

The roof of the structure needs to be driveable and therefore is designed for highway (HS-20) loads. After penetration of the AWS pump intake roof to accommodate the pumps, the structure will be flooded with water and cannot be dewatered. Consequently, the normal design for the structure is for an internal pressure equivalent to a pumped head of 4 feet of water above tailwater. Seismic accelerations are applied to the mass of water inside the structure, the structure itself, and the backfill.

It is assumed in the design that no backfill will be placed until the intake roof penetrations are made and the interior flooded, which will partially offset the exterior loads. This allows for an economy of structure, as the structure would never see hydrostatic groundwater pressures from the outside since the structure interior cannot be dewatered after construction.

The basic design philosophy for the structure is to recreate in the new structure the load paths found in the existing structure. Based on a review of the drawings for the existing structure, the west wall spans vertically and applies loads to the deck slab at the top and to the slab at the intake roof at the bottom. Since the new structure will have to transfer backfill loads to the existing structure in a similar fashion, the structure is designed in a similar manner. The new outside wall spans horizontally between the new pump chamber divider walls which act as deep beams spanning vertically between the deck slab and the intake roof slab at the bottom of the structure. These slabs carry the loads from the pump chamber divider walls to the existing structure.

To construct the new structure, an excavation 45 ft. deep will need to be made to access the roof of the AWS pump intake. An excavation of this magnitude in this location will be a significant disruption to normal vehicle access to the tailrace deck and adjacent areas. Installing a temporary bridge across the fish ladder could provide vehicle access. Also, the adjacent fish ladder structure may need to be protected during the excavation. The ladder foundation consists of concrete footings which extend to bedrock. Thus, settlement of the structure due to construction activities may not be an issue, however, this should be investigated during final design. Fill under the ladder will need to be protected since the adjacent excavation extends below the floor of the ladder. The horizontal extent of the excavation can be reduced if the contractor employs conventional vertical excavation techniques using shoring and soil anchors.

Dewatering of the excavation may prove to be a formidable task given its close proximity to the tailrace. The headwall of the intake structure does provide a boundary for the excavation on the river side of the structure, but groundwater is likely to be plentiful. Water pumped from the excavation will need to be routed away from the river for disposal.

c. Concrete Removal:

Accomplishing the three 96-inch diameter penetrations in the 7-foot thick roof of the intake structure (bottom of the new structure) will be complicated by a lack of dry access to the underside of the roof. It may be possible to fabricate a caisson that can be floated down into the intake and then pumped dry in the proper location. This seems to be a rather improbable scenario. Rather, it seems most likely that the concrete removal in the roof slab would have to be made entirely (or mostly) in a fully watered chamber. Concrete removal underwater is not uncommon and was performed at Wanapum Dam in 1994/1995 for a similar sized hole through comparable thicknesses of concrete. This is the more likely approach to this work.

The six penetrations (four 60-inch square and two 48-inch square openings) in the approximately 4-foot thick west wall of the existing structure can be accomplished during the ladder maintenance window which will enable dry access (or at least dry conditions) on the east side of the wall (inside the 3-foot wide chamber). These penetrations would be made prior to the roof penetrations to take advantage of dewatered conditions inside the new structure. All concrete removal work would be accomplished in the fully constructed chamber. Removal of the materials would be through the access hatches in the roof of the new structure.

An analysis of the existing structures has not been performed with regard to the concrete penetrations. However, it appears that the penetrations through the roof of the intake will actually reduce overall loading of the roof slabs since the penetrations result in the area above the structure being hydraulically connected to the water conduit. This results in the elimination of 45 feet of overburden for which the structure was originally designed. The 4 and 5-foot square penetrations through the (battered) 4-foot thick west wall of the existing structure are located towards the upper portion of the wall and should be justifiable based on the reduced loading on the wall resulting from the new pump station. This is because the wall was originally was designed for backfill up to El. 558 ft. while for this alternative, soil loads are replaced with hydrostatic loads at a normal maximum water surface 17 feet lower. This will reduce wall loads substantially under normal operating conditions and will only be critical when the diffuser conduit is dewatered.

4.8.2.5 Electrical

a. System Loads:

The AWS intake-located pumping station will consist of three electric pumps, two 500 hp, and one 300 hp. This scheme will be able to derive its power from the existing station service busses by using 1300 kVA of a spare capacity of 2056 kVA. The uneven distribution of station service loads between the two station service busses eliminates the possibility of connecting all of the pumps to a single bus. Currently Bus 1 has spare capacity of 878 kVA, which would accommodate one 500 hp motor. Bus 2 has 1181 kVA, which would be able to accommodate the remaining 300 and 500 hp motors. Two new 5 kV circuit breakers will be added to the station service switchgear with the downstream power conductors using the high-voltage cable tray. The conductors will use new conduit between the cable tray in the powerhouse and the new pumping station. Minor amounts of additional power will be required for small motor loads, instrumentation, controls, and lighting. This will be derived from a transformer and power distribution panel to supply low voltage power for the pumping station. Instrumentation and control wiring will be brought from the pump control center through new conduit, and connected to the plant control system. This scheme will permanently connect one 500 hp pump and one 300 hp pump to Bus 2, and one 500 hp pump to Bus 1.

There are disadvantages associated with permanently connecting the motors to separate busses, but there is not sufficient capacity in the current station service equipment to operate all of the pumps simultaneously from the same bus. In the case where one of the station service busses is unavailable, the pumping station would not be able to provide sufficient flow. The shortfall would depend on which of the two busses failed since Bus 1 has one 500 hp pump and Bus 2 has one 300 and one 500 horsepower pump connected. The costs associated with a capacity upgrade of the existing station service equipment would be prohibitive. However the probability of one bus being inoperable for an extended period of time (longer than 24 hours) concurrent with a failure of a turbine pump is unlikely.

The 300 hp pump could easily be operated from a portable generator. The 500 hp pumps could be operated from portable generators if the full-voltage motor starters were replaced with "soft" starters or variable frequency drives. Variable frequency drives also allow the flexibility of being able to operate the pump at any speed within its range of operation. Continuously variable speeds will result in continuously adjustable flow rates.

b. Power Supply and Routing:

This scheme will require the addition of two 5 kv circuit breakers, one from each of the two station service busses. These will be connected to a 5 kv motor control center near the new pumping station. Power will be carried from the new circuit breakers in the station service switchgear through the existing high voltage cable tray to the vicinity of the new pumping station. New conduit will be brought through the powerhouse wall and under the tailrace deck, so that the roadway will not be obstructed.

4.8.3 Estimated Construction Costs

The following table presents the estimated construction costs for Alternative 5. Detailed cost information for Little Goose EAWS system alternatives is provided in Appendix C.

DIRECT CONSTRUCTION COSTS	**$2,972,710**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$148,636
General Contractors Overhead and Profit (26.5%)	$827,157
CONSTRUCTION SUBTOTAL	$3,948,502
Construction Contingency (25%)	$987,126
TOTAL CONSTRUCTION COSTS	**$4,935,628**
PLANNING AND ENGINEERING (22.5%)	$1,110,516
CONSTRUCTION MANAGEMENT (12.5%)	$616,954
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$6,663,098**

4.8.4 Conclusion

The following section discusses how Alternative 5 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: Like Alternatives 1, 2 and 3, Alternative 5 accomplishes the goal of providing one-pump "spare" or emergency flow capacity to the auxiliary water system. Like Alternative 2, flow is delivered not to the AWS pump chamber but to one of the supply conduits leading to diffusers. Unlike Alternative 2, however, none of the flow from the EAWS can be directed back to the AWS pump chamber. This is because no independent control exists, nor appears to be feasible, at the individual entrances to the diffusion chambers for Diffusers No. 1 and 2. Thus, it would not be possible to throttle the flow to these diffusers and force EAWS flow back up the supply conduit to the pump chamber and the rest of the system. This does reduce the operational flexibility of the system somewhat over Alternatives 1 and 2.

Like Alternatives 1, 2 and 3, the system can be brought on line in a relatively short period of time. The actual startup time associated with Alternative 5 is likely to be shorter than Alternatives 1 and 2, but longer than Alternative 3 (which only requires swapping bulkheads from the spare pump to the failed pump). This is because there are no fish screens to prepare for operation as found in Alternatives 1 and 2. The only required activity is to close the existing sluice gates to Diffusers No. 1 and 2, open the new ones from the EAWS pump station, and start the pumps.

Design and Construction Issues: Of all the EAWS alternatives, the design of Alternative 5 is likely to be the least complex. It is effectively three large concrete boxes, each fitted with a pump. There are no fish screens to design and no special throttling equipment except the very conventional sluice gates, which are vendor items. The concrete penetrations in the existing structure should be very easy to justify from a design standpoint.

Being a reinforced concrete structure with few mechanical parts except the sluice gates and pumps, the long-term durability of the installation should be excellent.

The constructability of the system is straightforward with the greatest challenge coming from dewatering the excavation during construction and providing shoring to protect the fill material under the adjacent fish ladder. Removal of concrete to make the 96-inch diameter concrete penetrations for the pumps is made more difficult due to the need to do this underwater. However, firms specializing in underwater construction will have no difficulty in accomplishing this.

Impacts to dam operations during construction should be minimal. Access to the tailrace deck will be provided by a temporary vehicle bridge over the fish ladder, minimizing the impacts to operations. Employee parking will need to be relocated during construction and visitor activities may be impacted. Cleaning of the AWS pump intake racks may be a problem during construction so this activity might have to be scheduled during another time.

Construction impacts to the AWS system would occur due to the removal of the concrete at the pump openings in the intake roof and at the new sluice gate locations in the existing west wall. Both would require the system to be shut down during the normal ladder maintenance period in January and February. To make best use of the limited time during this shutdown, it is assumed that the sluice gates would be installed prior to the penetrations for the gates being made and prior to the shutdown. Thus, the work sequence during the ladder maintenance window would involve removing the concrete at the sluice gate penetrations, closing the sluice gates, and then making the intake roof penetrations for the pumps. It may be necessary to extend the maintenance window slightly to accomplish the installation of the pumps. Any extensions of the ladder shutdown would require coordination with resource agencies and COE biologists.

<u>Operations and Maintenance Issues:</u> The systems associated with Alternative 5 should be very compatible with current dam operations. The proposed improvements are all below grade and should not interfere with any existing systems.

The reliability of the Alternative 5 systems should be very good because it employs proven, conventional technologies in the submersible pumps and sluice gates.

The operability of the EAWS system for Alternative 5 should be very good. In fact, it should be better than both Alternatives 1 and 2, since there are no systems to operate except the pumps. Alternative 5 is only surpassed by Alternative 3 in terms of operational simplicity.

Maintenance issues related to Alternative 5 will be limited to the pumps. When a pump requires maintenance, the deck hatch would be removed, divers would connect the lifting fixture, and a crane would hoist the pump to the tailrace deck elevation.

Construction and O&M Costs: The estimated construction costs for this alternative are presented in Section 4.8.3 and compared to the other comparable alternatives at Little Goose (Alternatives 1, 2, and 3), are second lowest next to Alternative 1 and can be considered as being virtually the same as Alternative 1 at this level of design development.

The daily maintenance costs for this alternative are expected to be comparable to Alternative 3 (which only has pumps) and less than Alternatives 1 and 2 which have fish screens. From a long-term maintenance standpoint, the relatively high cost of the pumping equipment (and more expensive maintenance thereof) certainly makes this a less attractive alternative than the more simplistic gravity option for Alternative 1. The Corps is familiar with and accustomed to large pumping stations, however, and this is not seen as a serious issue. Certainly, the O&M cost projections for the project will need to be adjusted for this additional maintenance.

As was noted in the discussions for the other alternatives, the cost of operating the EAWS system must include the energy costs. These compare very favorably to the value of the energy lost for Alternative 1 ($10,000 per year for the assumed month-long use of the pumped EAWS systems compared to over $100,000 per year for Alternative 1 assuming $17.45 per MW hour). If the use of the system is expanded to provide a source of supplemental flow for the AWS system, the cost of operating the system will obviously increase.

Other Issues: More so than any other alternative, use of Alternative 5 as a supplemental flow system to the AWS system (not its intended design use) is problematic given the dedication of the EAWS to Diffusers No. 1 and 2 and the inability (at least in the depicted design) to pump flow up the conduit and back into the pump chamber.

Conclusions: Alternative 5 is a very viable alternative. It represents a very straightforward design and construction effort. It is considerably less flexible, however, from an EAWS operations viewpoint than the other alternatives given the dedication of the supply to Diffusers No. 1 and 2. It has good O&M characteristics, and a cost that is the second lowest of the other alternatives (virtually the same as Alternative 1) with the added benefit of being less expensive to operate in terms of energy costs than Alternative 1. It is seen as being the least able to be adapted as a supplemental flow source for the AWS system.

4.9 ALTERNATIVE COMPARISON

4.9.1 Alternative Comparison

The table below provides a tabulation of the various Little Goose EAWS alternatives and allows for a direct comparison of each alternative against the criteria and issues discussed earlier in the report. Note that Alternative 4 has not been included in the matrix since it is not a comparable alternative in that it does not provide EAWS. This will be discussed in Section 4.9.2. A cost summary for the Little Goose alternatives follows the comparison matrix.

Criteria Conformance Ratings:
E = Excellent
G = Good
F = Fair
P = Poor

Little Goose EAWS	**Alternative No. 1 -** Gravity Feed From Forebay	**Alternative No. 2 -** Tailrace Pump Station	**Alternative No. 3 -** AWS Pump Upgrade	**Alternative No. 5 -** Pump Station At AWS Intake
EAWS Criteria:				
Provides one-pump "spare" flow capacity	E	E	E	E
Provides EAWS water to desirable location	E	G	E	F
System can be made operational in < 24 hours	E	E	E	E
Design and Construction:				
Design complexity	G	F	P	E
System durability > 25 years	E	E	E	E
Constructability	G	G	F	G
Impact to dam operations during construction	G	G	G	F
Impact to AWS system during construction	E	E	P	E
Operations and Maintenance:				
Compatibility with existing dam operations	E	G	E	E
System reliability	G	G	E	E
System operability	E	G	E	E
System maintainability	G	F	E	E
Cost:				
Construction cost	G	F	P	G
Maintenance cost	G	G	E	G
Operations cost (energy costs)	P	G	E	G
Other:				
Capable of providing supplemental flow (non-EAWS)	E	F	F	P

Little Goose EAWS Alternative Comparison Matrix

Little Goose EAWS Alternative	Construction Cost [1]	Total Cost [2]	Comments
Alternative 1[3]	$4,776,227	**$6,447,906**	
Alternative 2[3]	$8,701,465	**$11,746,978**	
Alternative 3	$10,878,471	**$14,685,936**	
Alternative 4	$50,576	**$68,278**	Does not meet EAWS criteria
Alternative 5[3]	$4,935,628	**$6,663,098**	

(1) Includes contractor mob/demob,OH and profit, and a 25% construction contingency
(2) Includes engineering and planning, and construction management
(3) Alternative 4 costs not included in costs for these alternatives (not applicable to Alternative 3)

Little Goose EAWS Alternative Cost Summary

4.9.2 Recommendations

From the above comparison, it can be readily seen that Alternatives 1 and 5 compare very favorably to each other. Alternative 3, despite being good in most regards, must be eliminated because of excessive construction cost compared to the other comparable systems. Alternative 2, because of the combined need for pumps and fish screening equipment (both costly components), is considerably more expensive than either Alternatives 1 or 5.

Thus, in selecting between Alternatives 1 and 5, it is noteworthy that Alternative 1, while being more expensive to operate from a energy standpoint (lost power generation potential) and while being more complex from a maintenance standpoint due to the fish screens, provides flow directly to the pump discharge chamber where it can be used most flexibly and also is most directly adapted to non-EAWS purposes (AWS flow supplementation). It also does not require maintenance of pumps which, while reliable, are inherently less reliable than gravity.

Alternative 5, on the other hand, is a very simple alternative and provides EAWS flow in a reliable way to Diffusers No. 1 and 2, allowing the remaining AWS pumps to provide flow to the remainder of the fishway.

Because of the inherently more simplistic system represented in Alternative 5, this must be the recommended system. If flow supplementation becomes a critical issue for the project, this should be identified prior to the final design of the system to make proper design modifications to the alternative to achieve this goal presuming that it is feasible from an AWS system-wide perspective.

Alternative 5 (and of course Alternatives 1 and 2), can benefit from the reliability upgrades and increased spare parts inventory associated with Alternative 4. It is therefore recommended that Alternative 4 be coupled to any EAWS system improvements.

As mentioned earlier, Alternative 4 does not meet basic EAWS criteria and therefore cannot be considered as an EAWS system alternative.

4.9.3 Design and Construction Schedule

A design and construction schedule has been developed for Alternative 5, the recommended alternative for Little Goose. This schedule is presented on the following page. Specific issues of note in the schedule includes constraints associated with the construction of the concrete penetrations for the sluice gates and pump openings in the existing structure. Both of these activities are required to be performed and completed during the fish ladder maintenance window starting January 1 and ending February 28.

The total duration is estimated to be from the start of design on June 1, 2001 to completion of operational tests in late March, 2003. The start date for the project is somewhat arbitrary and could be earlier allowing more time for construction and design. The durations and dates shown here, however, are reasonable for the complexity of the design and construction for this alternative. It should be noted that certain critical construction activities may involve multiple crews to accomplish the work. This is particularly true for the critical concrete removal activities during the maintenance window.

The permitting and agency coordination activities are less well known. It is likely that these will involve an ongoing process starting with this Phase II Technical Report. For more information on environmental requirements, see Section 6 in this report.

ID	Task Name	Duration
1	Little Goose EAWS Alternative 5	471 days
2	Design, Planning and Permitting	164 days
3	Planning and Design	120 days
4	BCOE Review	22 days
5	Permitting	142 days
6	Agency Consultation	65 days
7	Final Construction Documents	22 days
8	Construction	307 days
9	Contracting	29 days
10	Advertisement	22 days
11	Bid Evaluation	5 days
12	Bid Award	2 days
13	Contractor Mobilization	75 days
14	Pre-Construction Meeting/Mobilization	10 days
15	Submittal Preparation	43 days
16	Material Procurement	22 days
17	Site Work	111 days
18	Install Temporary Vehicle Bridge	5 days
19	Demolition of AC Paving	2 days
20	Excavation for Pump Station	36 days
21	Site Dewatering	96 days
22	Structure Backfill and Compaction	10 days
23	Restore AC Paving (3")	3 days
24	Remove Temporary Vehicle Bridge	5 days
25	Pump Station Structure	148 days
26	Drill and Grout Reinforcing	20 days
27	Reinforced Concrete Structure	30 days
28	Install Sluice Gates (6 total)	15 days
29	Install Pump Supports	5 days
30	Concrete Demolition (Sluice Gates)	10 days
31	Concrete Demolition (Pump Openings)	30 days
32	Install Pumps (3)	4 days
33	Electrical	112 days
34	Electrical Construction	112 days
35	System Startup and Testing	14 days
36	System Startup and Testing	14 days

Little Goose EAWS
Alternative 5 Construction
Sverdrup Civil, Inc.

Task | Split | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Split | Rolled Up Milestone | Rolled Up Progress | External Tasks | Project Summary

Design and Construction Schedule – Alternative 5

SECTION 5 - LOWER GRANITE LOCK AND DAM

5.1 GENERAL

Lower Granite Lock and Dam, completed in 1975, is located on the lower Snake River at River Mile 107.5. The normal range of forebay elevations is 733 to 738 ft. above mean sea level (msl). The tailwater elevation typically varies between elevations 633 to 642. The main project features of the dam include a powerhouse with six main turbine units, a concrete spillway with eight 50-ft. wide spillways separated by 14-ft. piers, a navigation lock, concrete and earth fill non-overflow sections, juvenile fish collection and bypass facilities, and a single adult fish ladder on the south shore and associated fishway collection system with entrances on the north shore and south shore and along the downstream face of the powerhouse.

5.2 EXISTING SYSTEM

5.2.1 Existing System Description

5.2.1.1 Fish Ladder

The adult fishway at Lower Granite consists of a fish ladder on the south shore with entrances on the south shore, across the downstream face of the powerhouse, at the non-overflow section between the powerhouse and spillway, and on the north shore (Figure 5.1). The fish ladder is 20 feet wide with a floor slope of 1 vertical to 10 horizontal for Weirs 634 through 727 and 1 vertical to 32 horizontal for Weirs 728 through 737. Along the length of the ladder are 97 dual-crest overflow weirs and 10 vertical slot and orifice control weirs. The overflow weirs have two 18-inch by 18-inch orifices at the bottom to allow low level fish passage. The orifice and vertical slot control weirs are 6 feet high with two low level orifices, 18 inches by 24 inches high, and a 1-foot wide variable height slot in the middle. Flow to the top of the ladder is provided by a gravity system supplying Diffuser 14. During emergency operations for the ladder when the forebay is lowered to El. 710 ft. in preparation for large flood events, three vertical pumps located on the forebay wall can supply water directly to the top of the ladder, to Diffuser 14, and to a false weir next to the regular exit. An 18-inch pipe is employed during these events to allow safe passage from the exit to the lowered forebay.

A junction pool at the bottom of the fish ladder splits the ladder flow to the various fishway entrances. These include two entrances on the south shore (SSE-1 and SSE-2), three powerhouse fish collection channel entrances (NPE-1, NPE-2, and NPE-3) plus four floating orifice entrances, and three north shore entrances (NSE-1, NSE-2, and NSE-3). Entrances NPE-3 and NSE-3 are not normally operated. Flow to the north shore entrances is supplied by a continuation of the powerhouse collection channel that continues past the powerhouse running through the central non-overflow dam section and then through the spillway monolith to the north fishway entrance. The ladder exit is located at the forebay on the south end of the powerhouse.

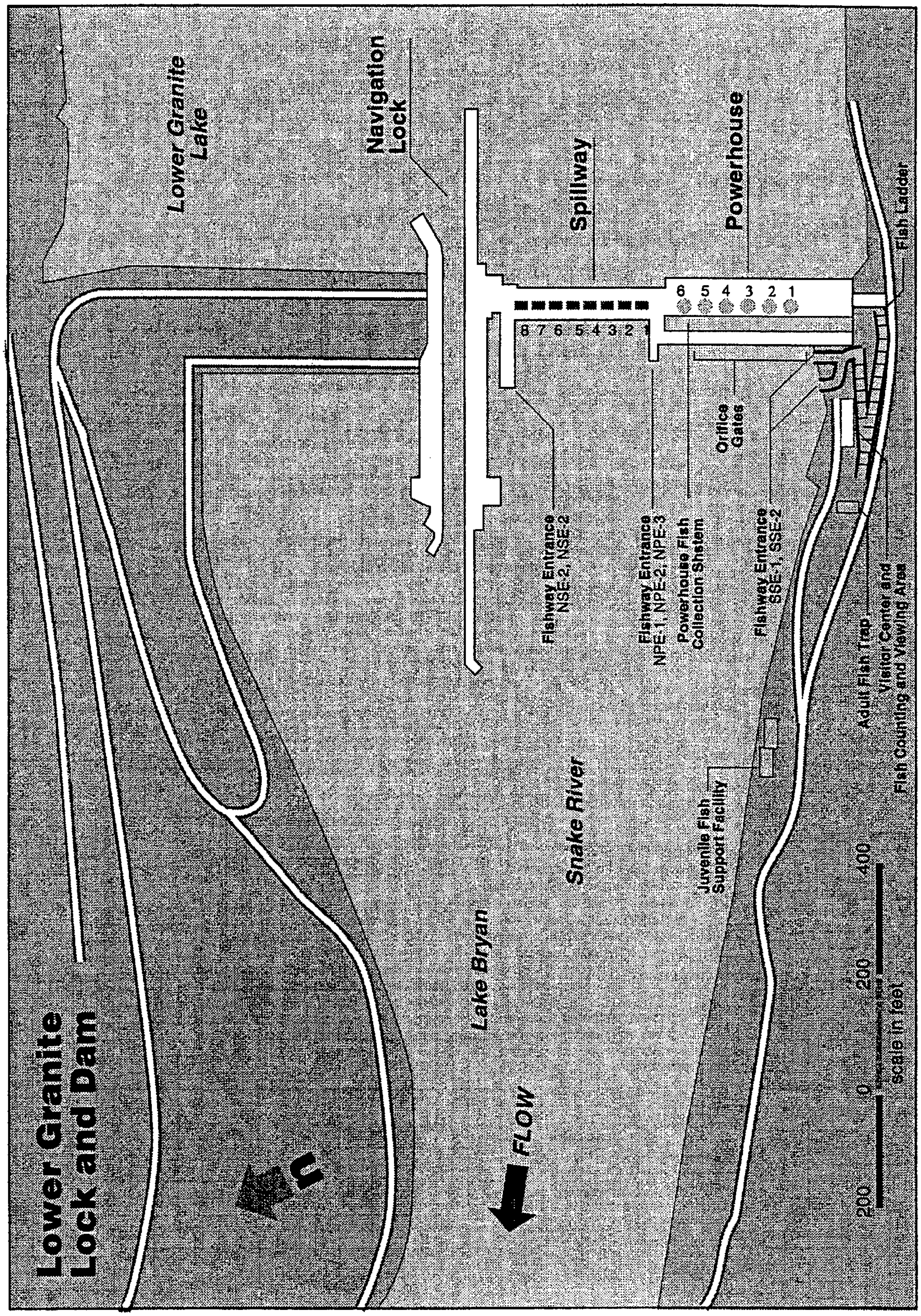


Figure 5.1 Lower Granite Lock and Dam general site plan.

5.2.1.2 Auxiliary Water Supply System

The auxiliary water supply system for the fishway provides supplemental flow to the north and south shore ladder entrances as well as the powerhouse collection channel entrances to supplement the 75 cfs supplied by the ladder itself. The auxiliary water supply system has two components. The first component, a gravity supply system at the ladder exit, supplies the upper portions of the ladder and contributes to the total ladder flow of 75 cfs, providing for a constant flow at all times in the ladder. The second component, a pumped system, supplies auxiliary water through diffusers in the floor of the ladder or channel to supplement the flow in the north and south fishway entrances and the powerhouse fish collection channel. A possible third component may be added in the future and would entail diverting approximately 200-250 cfs of excess water from the dewatering structure at a planned new juvenile fish facility at the project. This component would presumably be similar to the existing system at Little Goose and would supply water to the pump discharge chamber on the south shore.

The pumped system consists of three electric motor-driven pumps, with a maximum total rated capacity of 3,150 cfs at 4 feet of pumping head. Pumping Units 2 and 3 each consist of a single-speed, 800-hp electric motor, a gear box, and an axial-flow, fixed-blade propeller pump. Pumping Unit 1 is similar except that it has a two-speed motor that it is rated to deliver either 1,050 cfs at high speed, or 445 cfs at low speed, both against 4 feet of pumping head. Typically, only the two single-speed pumps operate, with the dual-speed pump reserved to provide extra water for high tailwater conditions (above 639 feet) and as a backup for the other two pumps. These pumps, located in the south shore pump house located in the Erection Bay, discharge into a pump discharge chamber. From here, the flow is routed through three separate conduits to the entrance and lower ladder diffusers in the south shore fish ladder, the diffuser between the spillway and powerhouse in the central non-overflow section, and to the fish collection channel along the downstream powerhouse face. The pumps are manually controlled to provide the supplemental flow consistent with tailwater demands. Slide gates and orifices regulate this pumped flow into the system.

5.2.2 Existing System Evaluation

5.2.2.1 Hydraulic and Adult Fish Passage Evaluation

Flow rates supplied to the auxiliary water system: Flow can be supplied to the auxiliary system by any of three electric motor-driven pumps, each with a rated discharge capacity of approximately 1,050 cfs when operating with a pumped lift of 4 ft.

There is some uncertainty about actual flow rates supplied by the pumps. Evaluations conducted using physical model calibrations of fishway entrance flow rates, computational model analysis of the auxiliary water distribution system, and the manufacturer's supplied pump performance rating curves indicated that supplied pumped flow rates may be as much as 2% greater than to 19% less than the original project design requirements (*Hydraulic Evaluation of Adult Fish Passage Facilities at Lower Granite Dam*, July 1995) [3]. Sources of deviation may include:

- Undetected obstructions in the auxiliary water supply conduits
- Inefficiencies/head losses in the auxiliary water supply system that require operation with increased pumped head which in turn reduces pumped flow rates
- Excessive leakage that may be occurring from the collection channel which adds inaccuracy to the field rating of pumped flow rates and also requires additional flow to be supplied to the system to meet entrance criteria
- Pump units that are operating at less than design efficiency
- Evaluation errors

Although all of the above could have some influence, close correlation between flow rates determined from the manufacturer's rating curves and from analysis of the distribution system imply that the manufacturer's pump rating may be fairly representative.

Adult Fishway Performance: Substantial efforts have been made to refine fishway operation with the objective of complying with established criteria as described in the 2000 FPP [7]. In general the existing operation does comply. Exceptions are:

- Differentials generated at the North Shore Entrances are approximately 0.8 to 0.9 ft. which are lower than the 1.0 ft. FPP minimum.
- Transport velocities in the junction pool and south end of the powerhouse collection channel are typically lower than the 1.5 fps FPP minimum.

Simultaneous operation of two pumps is required to achieve this performance. As a consequence it appears that the third pump can function as a backup.

Fishway operation could be improved by reducing head losses in the auxiliary water distribution system and by reducing leakage from the fishway. Efforts might focus on improvement of the supply conduit configuration for Diffuser 13 located at the north end of the powerhouse.

Simultaneous operation of all three pumps (possibly with one pump operating at half speed) could also be used increase flow through the fishway system. It is likely that such an operation would increase flow rates at the North Shore Entrance, bringing generated differentials into compliance. An attempt to evaluate such an operation showed that when the pumps are operated at low tailwater (and in particular when Pump 1 is operating at low speed) there is a tendency for the pumps to overheat and overload as described in Section 5.2.2.2.

5.2.2.2 Mechanical Evaluation

The auxiliary water supply system pumps for Lower Granite consists of three electric-motor-driven pumps. The motors drive the pumps through right-angle gear drives. Pump 1 is two-speed; Pumps 2 and 3 are single speed. The pumps were placed in service in 1975 during the original construction of the dam.

The pumps were manufactured by Baldwin-Lima-Hamilton. Impellers are 3-blade, 126 inches in diameter. Rated speed is 78 rpm. Rated pump flow is 1050 cfs at 4 feet pump head. Pump 1 is also capable of low speed operation at 55.6 rpm; delivering 455 cfs at 4 feet pump head.

Pump 1 motor was manufactured by Hitachi and was provided as original equipment by the pump supplier. Pump 2 and 3 motors were manufactured by Ideal Electric and were Government Furnished for installation by the powerhouse contractor. Motors are horizontal, rated 800 hp, 705 rpm, 4-kV. Pump 1 motor can also operate at a low speed of 500 rpm, developing 510 hp.

Speed reducers are right angle spiral-helical design. The Falk Company originally manufactured all three speed reducers. Pump 1's Falk speed reducer was replaced with a Philadelphia Gear Company unit in 1978 after failure of the Falk unit, because Philadelphia could deliver the speed reducer in time for the next fish passage season while Falk apparently could not. Pumps 2 and 3 speed reducers remain Falk units. Speed reducer specifications are as follows:

Specification	Philadelphia (Pump 1)	Falk (Pumps 2 and 3)
Input RPM	500/705	708
Output RPM	55/77.6	78
Ratio	9.03:1	9.08:1
Rating, hp	510/800	800
Service (Safety) Factor	2/2	2

Gears and bearings are pressure lubricated. Water-oil heat exchangers maintain oil temperatures. Kingsbury thrust bearings are incorporated into the speed reducers to handle pump hydraulic thrust. The Falk units also incorporate anti-backspin devices to prevent backspin due to reverse flow when the pump is not operating. An external Formsprag holdback device on the input shaft provides anti-backspin protection for Pump 1.

As was noted earlier, two pumps are required to meet AWS requirements during the fish passage season. The pumps are manually controlled. Presently, only Pumps 2 and 3 are used. Pump 1 has not been used since 1995 according to plant personnel. It was originally reported that Pump 1's speed reducer was not operable. Subsequent discussions and research now reveal that the pump is believed to be capable of operation but that the Formsprag holdback tends to slip with reverse flow through the pump. Correcting this deficiency will provide three operable pumps, one of which would be available as standby for EAWS service.

To verify the present availability and reliability of Pump 1, the pump was tested on August 8, 2000. Problems noted during the test that precluded successful operation of the pump are:

- The pump shaft seal was found cracked, resulting in excessive water leakage.
- Pump bearing lubricating water flow was blocked. The blockage appears to be in the bearing supply piping.
- The Formsprag temperature alarm relay had been cannibalized for use on another pump and not replaced.

The plant plans to correct known problems and retest Pump 1 after the main fish run, probably in November.

With the exception of Pump 1, which has not been operated since 1995, the pumps have been well maintained through the years despite continued maintenance cost constraints. Various upgrades have been made over the years, including replacing the original grease lubricated pump bearings with water lubricated bearings and reworking the pump shaft seals.

A July 1995 hydraulic study indicated that the fish water pumps were operating at their original design capabilities. Comparison between computer modeling and the pump performance curves showed agreement within 6% when any combination of two pumps were operated. During tests run at normal tailwater elevations of 636.7 ft. with Pumps 2 and 3 operating at full speed and Pump 1 operating at low speed, all pumps apparently operated with no problems although pump tests were of a short duration (all pumps were operating simultaneously for less than one-half day). When the tailwater was dropped to elevation 633.2 ft., an unusually low tailwater condition, and the same test was run, Pump 1 cut off after two hours of operation. After several failed attempts at restarting the pump for continued operation, it was concluded that the pump motor was overloading and overheating and would not stay running for very long under those conditions. Pumps 2 and 3 were starting to heat up as well during this test. This can be expected as the power requirements, and thus motor currents, increase at increasing head. It was concluded that simultaneous operation of three pumps is not viable at very low tailwater elevations, but that normal pump operation can be expected for simultaneous operation of any two pumps regardless of tailwater conditions. Another problem with three-pump operation at low tailwater elevations is the limited outflow capacity of the diffuser system, causing a rise in discharge chamber levels, increasing the head on the pumps above four feet.

During the site visit in May 2000, Pumps 2 and 3 were observed to operate without undue noise or vibration. Pump 1 was not operating. Recent inspections by plant personnel reported that pump impellers are in very good condition.

Plant personnel reported that it is difficult to start the pumps at the beginning of the fish run due to the high viscosity of the speed reducer oil apparently causing the motors to overheat. Installation of electric heaters should eliminate this problem.

The original equipment, installed in 1975, has 25 years of service. The equipment has been overhauled, rebuilt and refurbished throughout the years. USACE ER 37-2-10 (Chapter 31, Appendix A), lists normal service life of motors, speed reducers, pumps and their major sub-components as follows:

- Pump Motor Winding — 20 Years
- Pump Impeller — 30 Years
- Thrust Bearing — 35 Years
- Speed Reducer — 40 Years

The service life of the equipment listed above have to be evaluated in the context of their present condition and the level of maintenance and upgrades. With the level of maintenance and upgrades at the plant, the pump units should have an effective service life of another 25 years.

Since the initial installation at Lower Granite, system reliability has been tied to that of the spiral-helical geared speed reducers. The other major components of the system have proven dependable. Work required on either the motors or the pumps have not resulted in substantial downtime during fish runs. The Phase I report indicated that the speed reducers were the weak link in the system, due to their age. As noted above, their age alone is not a good criterion for replacement.

The speed reducers were subject to major failures during the first 15 or so years of operation. The failures are summarized below:

Date	Speed Red.	Problem
October 1976	No. 1 (Falk)	Failed Input Shaft, Gear Damage
July 1977	No. 3 (Falk)	Failed Input Shaft
March 1978	No. 1 (Philadelphia)	Failed Low Speed Pinion
September 1978	No. 3 (Falk)	Bevel Gear Failure
January 1979	No. 1 (Philadelphia)	Failed Low Speed Pinion
September 1982	No. 2 (Falk)	Failed High Speed Pinion
March 1983	No. 2 (Falk)	Failed Bevel Gear/Pinion
March 1988	No.1 (Philadelphia)	Failed Bevel Gear. Replaced Bearings
February 1989	No. 1 (Philadelphia)	Failed Bevel Gear

Maintenance records available for review did not give complete details of failures in all cases. However, the records, and previous investigations, do indicate that most of the speed reducer failures have been related to manufacturer design deficiencies or quality control/manufacturing deficiencies. These problems have been corrected during the various rebuilds. The last recorded major failure was in February 1989. Since then, speed reducer reliability has been equal to or better than the other major pump unit components.

A spare Falk speed reducer is kept on site. Previous studies indicate that a Falk speed reducer can be replaced within two weeks [12]. Replacing the Philadelphia speed reducer with the spare Falk would take about 4 weeks as the previously removed Falk base, shafts and bearings, while still at the plant, would also have to be reinstalled.

Falk and Philadelphia Gear technical service personnel were contacted to determine replacement parts availability. Both firms maintain a stock of spare bearings and seals for the speed reducers. The manufacturers can manufacture major items such as gears and shafts from the original drawings. The pump manufacturer, Baldwin-Lima-Hamilton, is no longer in business. However, Ingersoll-Dresser Pumps, Liberty Corner, NJ, maintains drawings and patterns for Baldwin-Lima-Hamilton pumps and can produce repair parts should there be major failures. Both Ideal and Hitachi can service the motors. Minor items, such as instruments and auxiliaries, are readily available for all equipment.

Intake and discharge bulkheads isolate the AWS pumps. Intake bulkheads are needed only when the intake water passage or pump impeller area is to be serviced or inspected. Discharge bulkheads are installed when a pump is not operating to prevent reverse flow through the pump. The bulkheads are installed by the plant's mobile crane. Plant personnel estimate that the installation of intake bulkheads takes about three hours on a weekday day shift and about 7 hours at other times due to the need to call out personnel. This is well within the criteria of providing an alternate source of EAWS within 24 hours on a major equipment failure event. Therefore, the existing bulkhead system is satisfactory.

5.2.2.3 Electrical Evaluation

The three pump motors are locally controlled using four medium voltage motor starters. The four starters are mounted in a single enclosure in the pump room. The motor for Pump 1 has two starter units, one for each speed. Pumps 2 and 3 are single-speed pumps and each requires a single starter. The current system drawings indicate that the pumps derive their power from two separate busses, Bus 1 and Bus 2. Bus 1 feeds Pump 2 and 3 while Bus 2 feeds Pump 1. As has been noted earlier, in order for the system to provide sufficient water there needs to be at least two pumps in operation. Failure of the source feeding the two pumps (Bus 1) or failure of the feeder from Bus 1, would leave the system with only 1 operational pump (Pump 1) which by itself is unable to provide sufficient water. Failure of Bus 2 or the feeder from Bus 2 would result in a lack of redundant spare pump capacity. Thus, the electrical system needs to be reconfigured to improve reliability such that failure of power from either Bus 1 or 2 will not result in loss of capacity.

Another weakness in the current system is the controller enclosure. An electrical fault within the enclosure could severely damage the equipment and cause an extended outage of all three pumps. The configuration of the controller enclosure should be revised to rectify this problem.

5.2.3 Evaluation Summary

Like the system at Little Goose, the existing auxiliary water system at Lower Granite has generally been a reliable system over the years, thanks in part to a consistent maintenance program. The speed reducers, which were very unreliable in the early days, appear to have had the systemic problems corrected through numerous rebuilds and now match the other components in reliability.

However, a speed reducer failure would still cause major disruption to the AWS. At the present time this is fairly well mitigated, as there is a spare Falk speed reducer on site. The Falk can also be installed on Pump 1 with some additional down time. Without the on-site spare, procurement of a new unit would require approximately 35 weeks. The electric motor-gear box-pump system appears to have considerable remaining service life based on the performance history of comparable systems.

The status of Pump 1 should be verified by a complete inspection followed by additional testing. Evidence from the 1995 pump tests suggests that it is comparable in discharge and performance to the other two pumps. Thus, operationally, all three pumps appear to be comparable.

Based on the operational history at the Lower Granite, only two of the existing three pumps are required to meet FPP criteria, although conformance to these criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and transport velocities below the 1.5 fps minimum transport velocity. Thus, there is a one-pump spare capacity at the project, meeting the spare capacity requirement listed in the assessment criteria.

The reliability of electrical power supply to the motors is not acceptable. This is due to the lack of redundancy of the power supply to the motors and the potential for a single-mode failure via an electrical fault in the electrical equipment enclosure.

5.3 DEVELOPMENT OF ALTERNATIVES TO BE REVIEWED IN THE PHASE II REPORT

5.3.1 Phase I Report Alternatives

Following the evaluation of the auxiliary water system at Lower Granite, which was performed in the preceding section, and following a review of the alternatives identified in the Phase I report alternatives, it is clear that not all of the alternatives reviewed in the earlier report are suitable for a more detailed review. In this section, each of the Phase I report alternatives for Lower Granite will be evaluated for merit for further investigation in this report.

5.3.1.1 Alternative 1 - Increase the reliability of the electrical supply and enhanced preventive maintenance program

In Alternative 1, the electrical reliability concerns of the AWS pumping system were addressed by proposing modifications to the electrical service to the pump motors. An enhanced maintenance program was also proposed for the motors, speed reducers, and pumps. As was noted in the Phase I report and confirmed in this report, the project has spare capacity in that only two of the three AWS pumps are operated and required to operate the fishway system to meet the FPP criteria. Thus, this alternative is feasible in that increasing the reliability of the existing equipment should result in meeting the spare capacity criteria. It was also confirmed earlier in this report that the electrical system should be upgraded to improve the reliability of the system. Consequently, this alternative should be advanced for a more detailed evaluation in this report and is listed as Alternative 1.

5.3.1.2 Alternative 2 - Gravity feed supply through south non-overflow section

In Alternative 2 in the Phase I report, spare hydraulic capacity equivalent to one pump was proposed to be developed for the AWS system through construction of a gravity feed system from the forebay through the south non-over section of the project. Flow would be routed to the AWS pump discharge chamber. Since, per the conclusions of the evaluation of the system in the preceding sections, spare capacity already exists at Lower Granite in that only two of the three pumps are required to operate the AWS, development of additional spare capacity beyond the existing spare capacity is not warranted and will not be pursued in the Phase II report.

5.3.1.3 Alternative 3 - Enhanced preventive maintenance program

Alternative 3 in the Phase I report focused on increasing the reliability of the existing system (particularly the electrical system) through enhanced preventive maintenance. The object of this program would be to anticipate possible equipment failures and work to prevent them through preventive maintenance as well as being prepared to resolve them promptly if they should occur. The electrical configuration deficiencies identified would not be corrected in the alternative. While similar to Alternative 1 in that the primary capacity requirements are met, this proposal can be accomplished at less cost with some decrease in reliability and a greater risk of losing two or more pumps. Thus, this alternative will be carried forward to this report as Alternative 2.

5.3.1.4 Alternative 4 - "No Action"

As was noted earlier, unlike Little Goose, Lower Granite does have existing spare capacity in the unused third AWS pump. Thus, the ability to keep at least two pumps running under the current maintenance program and parts inventory becomes the issue. While theoretically a "No Action" proposal could provide a reasonable level of assurance of continued operability of the fishway within

FPP criteria in that the spare pump exists, the electrical power supply concerns, which if not properly addressed could defeat more than one pump, makes this alternative inappropriate for further investigation.

5.3.2 Other Water Supply Alternatives

The issues at Lower Granite are considerably more straightforward than at Little Goose. Existing spare pumping capacity exists and the most cost effective means of accomplishing the goal of increasing reliability of the AWS is to make sure that the existing equipment is reliable. Consequently, evaluations of alternative water sources for the AWS (such as additional pump supplies from the tailrace and gravity feed systems from the forebay) will not be pursued in this report.

5.4 ALTERNATIVE 1 - ENHANCED MAINTENANCE AND EQUIPMENT RELIABILITY UPGRADES

5.4.1 General Discussion

Alternative 1 in the Phase I report reviewed a concept for increasing the electrical reliability of the AWS system to ensure continued availability of the pumps to provide water for the AWS system and to ensure that the third pump is available as an EAWS source. It also proposed a program of enhanced maintenance to increase overall reliability of the system. This alternative will be expanded in this Phase II report.

A third area mentioned in the Phase I report, a more aggressive operation and maintenance program, is not required. The maintenance staff is well aware of the importance to maintaining the AWS and repairs to the systems are a high priority. Preventive maintenance is also high with quarterly, semiannual and annual programs in effect. Even if it were valid, this solution would probably be nearly impossible to implement considering present and expected future budget constraints on maintenance functions.

This alternative would be a responsibility of Project Operations and would require increased funding through the Operations and Maintenance Budget.

5.4.2 Design Development Criteria

In refining this alternative for the Phase II report, the following criteria was used for design development:

- Pump 1 is an integral component of the EAWS system at Lower Granite and its readiness as a standby pump or one that regularly shares pumping duties must be confirmed.
- Known problems that cause lost time or service in the operation of the AWS system or problems presently preventing operation of AWS components should be corrected. Such problems either reduce reliability or cause the shutdown or startup of equipment to be excessively long.
- Increase the reliability of the electrical supply to the pumps.

- An inventory of spare parts shall be maintained to permit repair of minor auxiliaries within a 24-hour period.

5.4.3 New System Description

The following is a description of the major features and design considerations for development of Alternative 1. Electrical system upgrades for Alternative 1 are depicted on Plate 2.1.1.

5.4.3.1 Mechanical

a. Verify Pump 1 Operability:

As discussed in Section 5.2.2.2, Pump 1 has not been successfully operated since 1995. The reasons are unclear. Plant personnel believed the pump was operable with the exception of a faulty backspin device. Pump 1 should be operated to verify that all three pumps are capable of full AWS service. Deficiencies should be noted and appropriate remedies instituted at once.

To resolve the question of the readiness of Pump 1, it was recommended that the COE operate the pump to confirm its status [15]. The following test program was recommended:

- The pump would be operated in tandem with either Pump No. 2 or Pump No. 3. There is no perceived need to test all three pumps simultaneously since FPP criteria are apparently (nominally) satisfied with the operation of only two pumps.
- The pump would be operated for a minimum of one hour after temperatures stabilize to confirm its condition.
- Any mechanical/electrical anomalies observed during the operation of the pump would be noted. The following mechanical/electrical monitoring would be performed during operation of the pump:
  a. Pump, speed reducer, and motor temperatures
  b. Speed reducer oil pressures
  c. Pump speed
  d. Motor voltage and currents
- The project staff would be prepared to immediately terminate the test if equipment damage appears to be a possibility.

The operational test was performed on August 8, 2000 and found multiple deficiencies as described in Section 5.2.2.2. The plant plans to correct known problems and retest Pump 1 after the main fish run, probably in November.

b. Correcting Known Problems:

Problem: Pumps are difficult to start due to high oil viscosity in the speed reducers when the oil is cold. Operators have to go through several attempts until the oil is warm enough to prevent tripping the drive motor breaker. This can take several hours.

Recommended Solution: The recommended solution is to install an oil heating circuit to circulate speed reducer oil through an electric heater when the pump unit is not running. The circuit would consist of a connection to the pressure oil pump suction line, a small (1 or 2 gpm) circulating pump, an in-line electric heater and discharge filter and piping terminating at the sump oil drain port. The heater would be thermostatically controlled.

Problem: The Pump 1 Formsprag anti-backspin device slips under reverse flow conditions. This requires the discharge bulkheads to be installed whenever the pump is stopped. Otherwise the slippage shocks could damage the pump and speed reducer. The tenuous nature of this installation detracts from the pump serving as a reliable standby.

The described slippage is indicative of worn internal parts. The HDC designer and Formsprag's technical services representative both concur with this diagnosis. The adequacy of the Formsprag for the loads was questioned. HDC data indicates that the installed model, LLH-900 is rated for over twice the expected load.

Recommended Solution: The unit cannot be repaired in the field but must be sent to Formsprag for overhaul. This is about a two-month process at current factory workloads. The recommended solution would be to purchase a new unit for immediate installation and send the existing unit to the factory for overhaul. The overhauled unit would then be kept in inventory as a spare. An alternative solution would be to immediately have the present Formsprag unit repaired so it could be installed during the Year 2001 maintenance period, thus eliminating the cost of a spare. Because of past problems with the Formsprag unit and the long turnaround time for repairs, the AWS would be better served by maintaining a spare on hand as noted above.

Problem: Multiple Types of Speed Reducers Installed. Having both Falk and Philadelphia speed reducers installed complicates maintenance and spare parts inventory. There is also the belief of plant and District personnel that the Philadelphia reducer is not as robust as the Falk reducers.

Recommended Solution: Replacing the Philadelphia speed reducer with the spare Falk will provide a common installation for all three pumps. The old Falk output shaft extension to the pump and the Falk structural base are stored on site. Since the Falk unit has a built-in anti-backspin device, the defective Formsprag device would not have to be replaced. From discussions with plant personnel, major speed reducer repairs would be more efficient if spare gears and shafts were available, rather than replacing the entire speed reducer. Spare gears and shafts are included in the enhanced spare parts inventory described below. Having a single speed reducer design would be an advantage. It is recommended that the Philadelphia reducer be replaced by the Falk reducer when a major overhaul is required.

c. Enhanced Mechanical Spare Parts Inventory:

This part of the alternative would provide a stock of spare parts to permit rapid replacement of failed items, thus improving overall system reliability. The items listed in the following table covers longer lead purchased items. Common materials such as pipe, fittings, small hand valves, conduit and wire would be readily available at the plant or quickly procured from local sources. The quantities should be sufficient for one pump unit.

Falk Lub.Oil Pump	Speed Reducer Gears and Shaft Set
Falk Thrust. Bearing Oil Pump	Speed Reducer Bearings
Philadelphia Lub.Oil Pump	Pump Shaft Seal
Philadelphia Thrust. Bearing Oil Pump	Pump Bearing Set
Speed Reducer Oil Flow Switch	Motor RTD Relay
Speed Reducer Temperature Transmitter	Thrust Bearing Shoes, Set (2)
Speed reducer Water Flow Switch	Water Solenoid Valves
Speed Reducer Temperature Relay	Formsprag Anti-backspin Device

Recommended Spare Parts Inventory

There is a complete spare Falk speed reducer on site. This will serve either Pump 2 or Pump 3. With three operable pumps, and only two required for AWS, it is not necessary to also have a spare Philadelphia reducer on site. Also, the spare Falk speed reducer could be refitted to Pump 1 with some additional installation delay.

5.4.3.2 Electrical

a. Correcting Known Problems:

Problem: As was noted in Section 5.2.2.3, the current system has Pumps 2 and 3 connected to station service Bus 1 and Pump 1 connected to Bus 2. Failure of Bus 2 would leave the system with only two pumps available (Pumps 2 and 3) and consequently without any spare capacity, while failure of Bus 1 would leave only one pump available (Pump 1) which would not provide sufficient flow for the fishway.

In evaluating reliability of the electrical system, the goal is to create a condition that should a failure occur to the electrical supply, a minimum of two pumps should be available at all times. During normal operating conditions, a spare (third) pump must be available to meet the EAWS one-pump spare capacity criteria, but not necessarily following an electrical system failure. This is consistent with the concept that from a pump reliability standpoint, the goal is to have three pumps able to operate during a normal operating condition, but should a mechanical failure occur in one of the pumps, two pumps would be remaining. It is not reasonable to postulate a failure of both the electrical system and a failure of one of the pumps due to mechanical problems. Thus, the deficiency to be rectified is the potential electrical system failure leading to less than two pumps available.

Recommended Solution: To ensure a minimum of two pumps available after an electrical system failure, the critical configurational change to the existing system is to address the potential failure of Bus 1 which would disable Pumps 2 and 3. This would be accomplished by the addition of a 5 kv automatic transfer switch. The automatic transfer switch would provide power only for Pump 1. Pump 2 would be permanently connected to Bus 2, and Pump 3 would remain permanently connected to Bus 1. If an electrical fault occurs in one of the station service busses, the transfer switch will change the source of power to the alternate bus to ensure a source of power for two pumps under all conditions. Thus, failure of Bus 1 would mean that Pump 3 would be disabled, but that Pumps 1 and 2 would be available. Failure of Bus 2 would mean that Pump 2 would be disabled, but that Pumps 1 and 3 would be available. The project would be capable of two-pump operation with an extended outage on either of the station service busses.

Problem: Also noted in Section 5.2.2.3, the motor control center has all the motor starters arranged as a single unit. This arrangement is prone to a single mode failure. It is possible for an electrical fault in one of the motor starters to disable the remaining starters.

Recommended Solution: To rectify this problem, the motor starters are separated into separate enclosures and are mounted adjacent to the motors.

b. Enhanced Electrical Spare Parts Inventory:

The most common failure of power supply to the motor starters has been the failure of the control power transformer. The control power transformer is connected to the 5-kV power supply feeding each of the motor starters, providing the power necessary to operate the motor starters. The failure of this transformer has left the individual motor starter inoperative until a new transformer can be ordered, delivered, and installed. This problem has occurred five times since the system was originally installed, and has typically left the pump inoperative for two to three days. Having the pump unavailable for such a long period of time leaves the system without any spare capacity while the repairs are being made. The five failures indicates a problem with the electrical circuits, not necessarily with an under-rated transformer as might first be assumed. The cause of the failures should be investigated by the plant to determine the correct course of action. Until the cause is determined, the simplest solution would be to maintain a stock of spare parts, including a spare transformer, thus eliminating the ordering and delivery portions of the repair. The repair itself should be accomplished in less than two hours.

5.4.4 Estimated Construction and Expanded Parts Inventory Costs

The following table presents the estimated construction costs for Alternative 1. Detailed cost information for Lower Granite EAWS system alternatives is provided in Appendix D.

DIRECT CONSTRUCTION COSTS	**$124,267**
CONSTRUCTION RELATED COSTS	
Mobilization/Demobilization (5%)	$6,213
General Contractors Overhead and Profit (26.5%)	$34,577
CONSTRUCTION SUBTOTAL	**$165,057**
Construction Contingency (25%)	$41,264
TOTAL CONSTRUCTION COSTS	**$206,321**
PLANNING AND ENGINEERING (22.5%)	$46,422
CONSTRUCTION MANAGEMENT (12.5%)	$25,790
TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)	**$278,534**

The cost for procurement of the proposed expanded inventory of spare parts for the Lower Granite AWS system is $144,130. Detailed cost information for the expanded parts inventory described in this alternative is provided with the construction cost estimate in Appendix D.

5.4.5 Conclusion

The following section discusses how Alternative 1 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: The Lower Granite EAWS requirement is presently met with the existing three pumps. Two pumps supply the required water and the third is a "standby". Alternative 1 would verify the operability of AWS Pump 1, improve electrical reliability to the pumps and correct known O&M problems. In addition, maintaining a supply of spare parts would minimize downtime due to failures in unit auxiliaries.

Two types of enhancements were considered: 1) Correction of known operating and maintenance problems to existing equipment, and 2) increased spare parts inventory to permit rapid correction of minor auxiliary equipment failures.

Design and Construction Issues: There are no major design issues involved in Alternative 1. The addition of speed reducer heaters and an automatic transfer switch, separated motor starters, and repair of the Pump 1 holdback device are straightforward designs. The modifications would be installed in the AWS pump room. Work can easily be accomplished during the normal AWS maintenance period.

Replacement of Pump 1 Philadelphia speed reducer with the spare Falk will require modification of the structural base and the pump connecting shaft. The parts are already on site.

Operations and Maintenance Issues: The systems associated with Alternative 1 would be quite compatible with current dam operations. The new components are similar to other systems at the dam. The additional recommended spare parts would require procurement and storage. The speed reducer oil heaters will be automatic, requiring little monitoring or adjustment and will reduce the effort needed to start up the system. The automatic transfer switch and motor starters would also be automatic in operation.

Construction and O&M Costs: The estimated construction costs for this alternative is presented in Section 5.4.4.

Conclusions: Adoption of Alternative 1 under the auspices of O&M will reduce downtime from failures of auxiliary or bus systems and consequently providing greater reliability to the AWS system.

5.5 ALTERNATIVE 2 - ENHANCED PREVENTIVE MAINTENANCE PROGRAM

5.5.1 General Discussion

As noted earlier, Alternative 3 in the Phase I report focused solely on increasing the reliability of the existing system through enhanced preventive maintenance by anticipating possible equipment failures and working to prevent them, as well as being prepared to resolve them promptly if they should occur through an enhanced inventory of critical parts. Unlike Alternative 1 described above, known electrical and mechanical configuration deficiencies would not be corrected in the alternative except as might be required to repair Pump 1.

5.5.2 Design Development Criteria

In refining this alternative for the Phase II report, the following criteria were used for design development:

- Pump 1 is an integral component of the EAWS system at Lower Granite and its readiness as a standby pump or one that regularly shares pumping duties must be confirmed.
- An inventory of spare parts shall be maintained to permit repair of minor auxiliaries within a 24-hour period.

5.5.3 New System Description

The following is a description of the major features and design considerations for development of the pump system upgrades.

5.5.3.1 General

This alternative is similar to Alternative 1 at Lower Granite (see Section 5.4) except that no physical modifications (except as might be required to repair Pump 1) would be made to repair known deficiencies in electrical and mechanical components. Increases in reliability would be obtained through enhanced maintenance.

5.5.3.2 Mechanical

Mechanical features for Alternative 2 are as described in Section 5.4.3.1 where they are related to enhanced maintenance. These include:

a. Verify Pump 1 Operability:

(See Section 5.4.3.1.a)

b. Enhanced Mechanical Spare Parts Inventory:

(See Section 5.4.3.1.c)

5.5.3.3 Electrical

Electrical features for Alternative 2 are as described in Section 5.4.3.2 where they are related to enhanced maintenance. These include:

Enhanced Electrical Spare Parts Inventory:

(See Section 5.4.3.2.b)

5.5.4 Estimated Expanded Parts Inventory Costs

The estimated cost for an expanded inventory of spare parts associated with Alternative 2 is the same as Alternative 1 and is estimated to be $144,130 as presented in Section 5.4.4 .

5.5.5 Conclusion

The following section discusses how Alternative 2 meets the criteria established earlier in this report with regards to providing emergency auxiliary water supply and addresses design complexity, constructability, operations and maintenance, construction and O&M costs, and other issues.

EAWS Criteria: As stated in Alternate 1, The Lower Granite EAWS requirement is presently met with the existing three pumps. Two pumps supply the required water and the third is a “standby”. Alternative 2 is a subset of Alternative 1 considering only additions to the spare parts inventory to minimize downtime due to the failure of unit auxiliaries.

Design and Construction Issues: There are no design or construction issues involved with Alternative 2.

Operations and Maintenance Issues: Other than storing spare parts, there are no Operations and Maintenance issues involved. A readily available supply of critical spare parts will enhance maintenance activities for and increase the reliability of the AWS pump systems.

Construction and O&M Costs: The estimated costs for this alternative are presented in Section 5.5.4.

Conclusions: Adoption of Alternative 2 under the auspices of O&M will reduce downtime for failures of auxiliary equipment providing greater reliability to the AWS system.

5.6 ALTERNATIVE COMPARISON

5.6.1 Alternative Comparison and Recommendation

Alternatives 1 and 2 are different only in that Alternative 2 does not include the equipment reliability upgrades proposed for the pumping equipment. The installation of the oil heaters, the repair of the anti-backspin device for Pump 1, and the planned replacement of the Philadelphia speed reducer with the Falk unit are all reasonable measures to increase the reliability of the systems and should be undertaken. Also reasonable are the separation of the motor control centers and the reconfiguration of the power supply to include an automatic transfer switch. It is felt that for the modest investment represented by these modifications, that Alternative 1 should be selected. The benefit of an enhanced parts inventory will only increase the reliability and decrease the maintenance pressures resulting from failure of critical parts. Thus, Alternative 1 is the recommended alternative at Lower Granite.

5.6.2 Design and Construction Schedule

All of the constructed features associated with Alternative 1 must be completed during the maintenance window for the fish ladders in January and February. Some of the work can be accomplished ahead of this shutdown with final tie-ins accomplished during the shutdown, but it is felt that the magnitude of the work is such that it can easily be accomplished during this window. Design activities can precede the construction activities without limitation. Permitting issues should be minor or non-existent for these modifications.

SECTION 6 - ENVIRONMENTAL REQUIREMENTS

6.1 GENERAL

Construction, installation, and operation of emergency auxiliary water supply systems for the existing auxiliary water supply systems at Little Goose and Lower Granite will require coordination with appropriate agencies, as well as compliance with applicable environmental laws and regulations. These requirements include the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Fish and Wildlife Coordination Act (FWCA), and various cultural resources and water quality laws. Coordination and compliance work will begin when the recommended alternative is defined.

6.1.1 NEPA Requirements

All options outlined within this Phase II report are consistent with a category of activities that carry out authorized project purposes at completed U.S. Army Corps of Engineers projects [refer to Engineer Regulation 200-2-2]. These activities have been determined to be categorically excluded from NEPA documentation. Appropriate documentation addressing NEPA laws and regulations will be drafted to warrant a categorical exclusion for the alternatives selected, based on project authorization for Little Goose and Lower Granite to provide upstream passage for adult salmon.

6.1.2. ESA Requirements

6.1.2.1 Anadromous Fish Stocks

Federal agencies are required to consult with NMFS for actions they intend to implement that may jeopardize the existence of ESA-listed fish stocks. The Snake River sockeye salmon (listed as endangered on December 20, 1991) and the Snake River spring/summer Chinook and fall Chinook salmon (upgraded from threatened to endangered by the proposed listing on December 28, 1994) pass around Little Goose and Lower Granite during their upstream migration as adults and their downstream outmigration as juveniles. Because the construction and operation of the auxiliary water supply systems at Little Goose and Lower Granite have the potential to affect listed salmon stocks, a formal or informal consultation with NMFS on these actions will likely be necessary.

6.1.2.2 Terrestrial Wildlife and Resident Fish

Federal agencies are also required to consult with the U.S. Fish and Wildlife Service (USFWS) for actions they intend to implement that may jeopardize the existence of ESA-listed freshwater fish stocks and terrestrial species. Although the endangered peregrine falcon, bald eagle, and bull trout may use the habitat around Little Goose and Lower Granite, it is anticipated that no impact to these species will occur. Therefore, consultation with USFWS will not be necessary for the species of concern, with the possible exception of bull trout.

6.1.2.3 The FWCA Requirements

Coordination with USFWS will occur to ensure compliance with FWCA.

6.1.2.4 Clean Water Act Requirements

Emergency auxiliary water supply alternatives that have any in-water discharge of fill material will require compliance with sections 404 and 401 of the Clean Water Act, Public Law 95-217, 1977. Any modification of water quality standards and/or in-water permits will be required from the State of Washington.

6.1.2.5 Cultural Resources Requirements

Coordination for cultural and historic properties must be in compliance with sections 106 and 110 of the National Historic Preservation Act, Public Law 89-665, 1996. All activities resulting from the implementation of these options will occur in previously disturbed areas and to facilities less than 50 years in age. Therefore, it is unlikely that these actions will result in an adverse affect to cultural resources. A request will be sent to the Washington State Historic Preservation Officer for a concurrence of no effect.

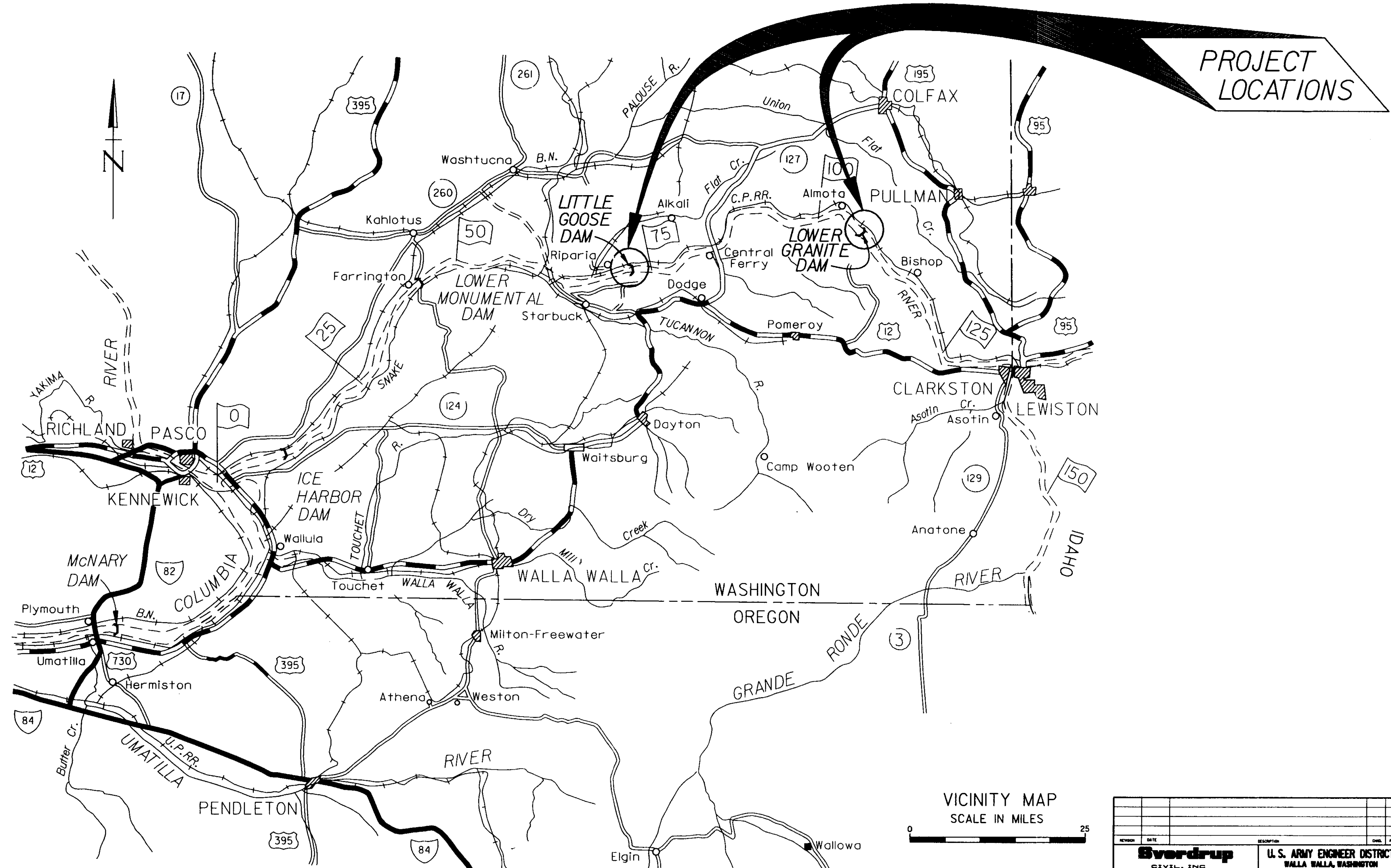
6.2 RECOMMENDED ALTERNATIVES

Formal consultation will be initiated with NMFS to seek their concurrence that the operation of the adult fishways and auxiliary water supply pump failures, while the systems are out of service during their overhaul, is unlikely to adversely affect individuals of listed salmon stocks.

An ESA consultation for the operation of the systems following the period of modifications will not be required, because they will operate in much the same manner as described in the FPP for the year of implementation. The NMFS has previously been consulted, and they have commented on the operation of fish pumps identified in the FPP in the Supplemental Biological Opinion, Operation of the Federal Snake River Power System, 2000. Recommended alternatives will be coordinated with Federal, State, and Tribal fishery agencies through the U.S. Army Corps of Engineers' Fish Facilities Design Review Workgroup process resulting in biological effect and benefit analysis evaluation to be included in the NMFS' Biological Opinion, Operation of the Federal Snake River Power System, 2000.

PLATES

CORPS OF ENGINEERS — SAFETY PAYS — U. S. ARMY

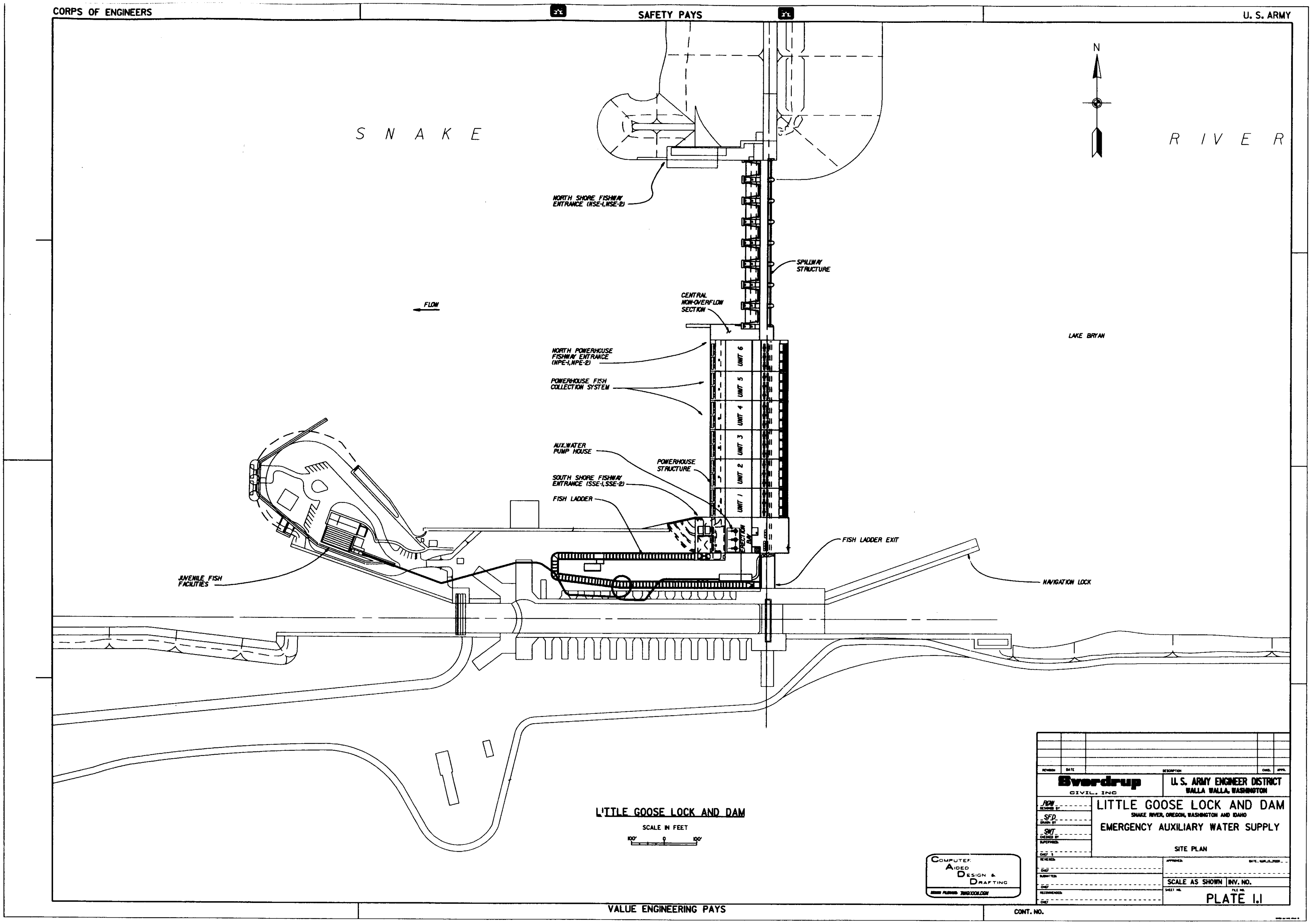


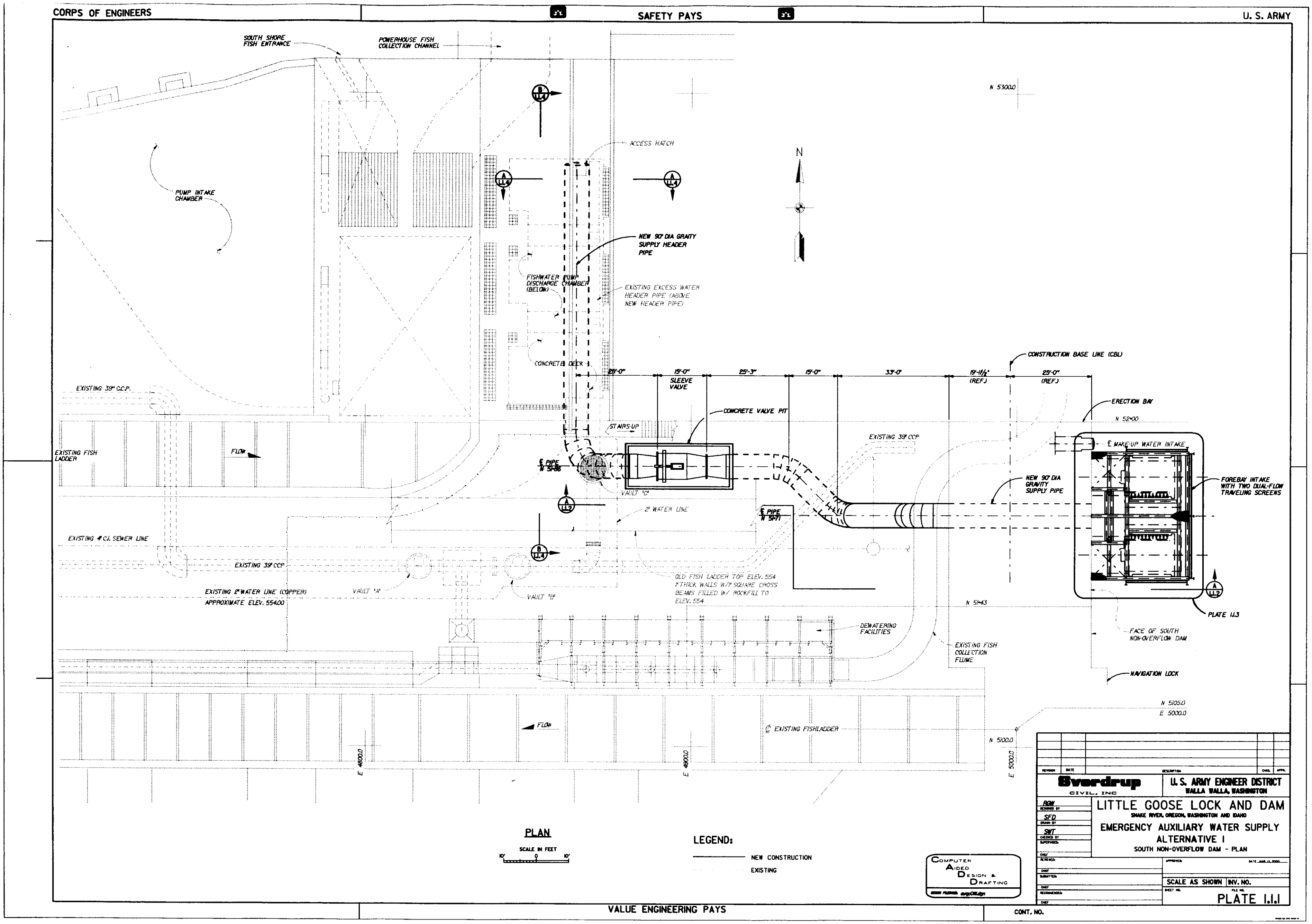
Sverdrup CIVIL, INC	U.S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
RPM / SFD / SMT	LOWER SNAKE RIVER
	SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
	EMERGENCY AUXILIARY WATER SUPPLY
	LITTLE GOOSE & LOWER GRANITE LOCKS AND DAMS
	VICINITY MAP
	SCALE AS SHOWN INV. NO.
	PLATE 1

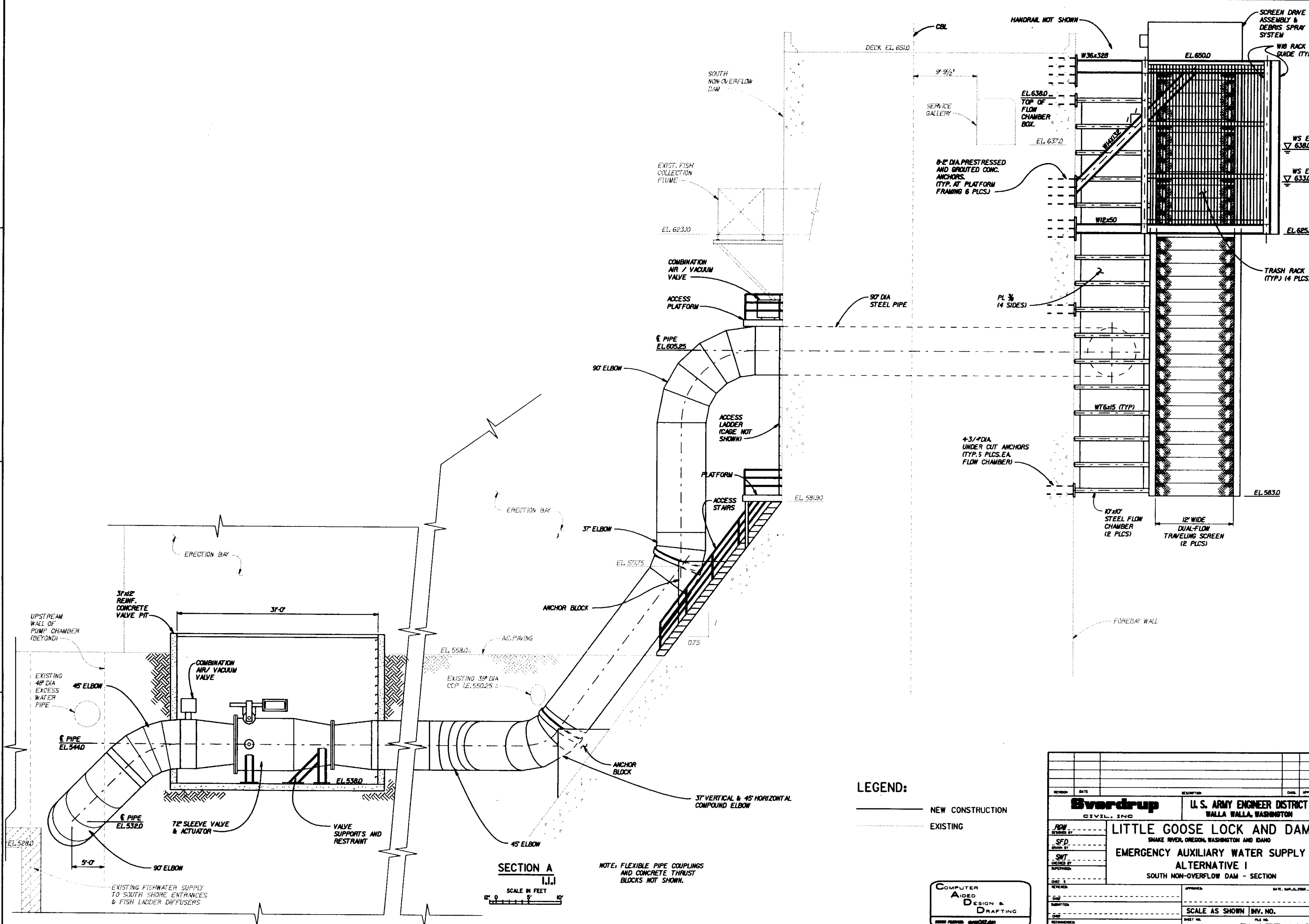
COMPUTER AIDED DESIGN & DRAFTING

VALUE ENGINEERING PAYS

CONT. NO.


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
S N A K E
R IV E R
N
NORTH SHORE FISHWAY ENTRANCE (NSE-1,NSE-2)
SPILLWAY STRUCTURE
CENTRAL NON-OVERFLOW SECTION
FLOW
LAKE BRYAN
NORTH POWERHOUSE FISHWAY ENTRANCE (NPE-1,NPE-2)
POWERHOUSE FISH COLLECTION SYSTEM
UNIT 6
UNIT 5
UNIT 4
UNIT 3
UNIT 2
UNIT 1
ERECTION BAY
AUX.WATER PUMP HOUSE
POWERHOUSE STRUCTURE
SOUTH SHORE FISHWAY ENTRANCE (SSE-1,SSE-2)
FISH LADDER
FISH LADDER EXIT
NAVIGATION LOCK
JUVENILE FISH FACILITIES
LITTLE GOOSE LOCK AND DAM
SCALE IN FEET
100' 0 100'
COMPUTER AIDED DESIGN & DRAFTING
Sverdrup CIVIL, INC
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
EMERGENCY AUXILIARY WATER SUPPLY
SITE PLAN
SCALE AS SHOWN
INV. NO.
PLATE 1.1
VALUE ENGINEERING PAYS
CONT. NO.


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
SOUTH SHORE FISH ENTRANCE
POWERHOUSE FISH COLLECTION CHANNEL
PUMP INTAKE CHAMBER
ACCESS HATCH
NEW 90" DIA GRAVITY SUPPLY HEADER PIPE
FISHWATER PUMP DISCHARGE CHAMBER (BELOW)
EXISTING EXCESS WATER HEADER PIPE (ABOVE NEW HEADER PIPE)
CONCRETE DECK
N 5300.0
N
CONSTRUCTION BASE LINE (CBL)
25'-0"
15'-0"
SLEEVE VALVE
25'-3"
15'-0"
33'-0"
19'-11½" (REF.)
25'-0" (REF.)
ERECTION BAY
N 5200
CONCRETE VALVE PIT
STAIRS UP
EXISTING 39" CCP
℄ MAKE-UP WATER INTAKE
EXISTING 39" C.C.P.
EXISTING FISH LADDER
FLOW
℄ PIPE N 5186
VAULT "C"
2" WATER LINE
℄ PIPE N 5171
NEW 90" DIA GRAVITY SUPPLY PIPE
FOREBAY INTAKE WITH TWO DUAL-FLOW TRAVELING SCREENS
EXISTING 4" C.I. SEWER LINE
EXISTING 39" CCP
EXISTING 2" WATER LINE (COPPER) APPROXIMATE ELEV. 554.00
VAULT "A"
VAULT "B"
OLD FISH LADDER TOP ELEV. 554 1' THICK WALLS W/ SQUARE CROSS BEAMS FILLED W/ ROCKFILL TO ELEV. 554
N 5143
PLATE 1.1.3
DEWATERING FACILITIES
EXISTING FISH COLLECTION FLUME
FACE OF SOUTH NON-OVERFLOW DAM
NAVIGATION LOCK
N 5105.0
E 5000.0
FLOW
℄ EXISTING FISHLADDER
N 5100.0
E 4800.0
E 4900.0
E 5000.0
PLAN
SCALE IN FEET
10' 0 10'
LEGEND:
NEW CONSTRUCTION
EXISTING
COMPUTER AIDED DESIGN & DRAFTING
Sverdrup CIVIL, INC
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
RGW
SFD
SWT
LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE I
SOUTH NON-OVERFLOW DAM - PLAN
SCALE AS SHOWN
INV. NO.
PLATE 1.1.1
VALUE ENGINEERING PAYS
CONT. NO.



LEGEND:

NEW CONSTRUCTION

EXISTING

COMPUTER AIDED DESIGN & DRAFTING

REVISION	DATE	DESCRIPTION	CHKD.	APPR.

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

RGW DESIGNED BY
SFD DRAWN BY
SMT CHECKED BY

LITTLE GOOSE LOCK AND DAM

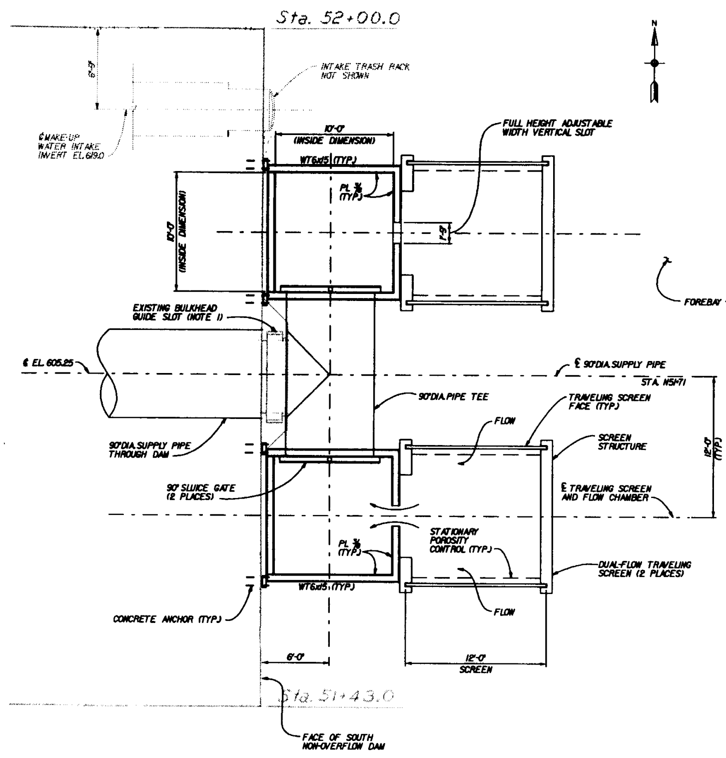
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE I

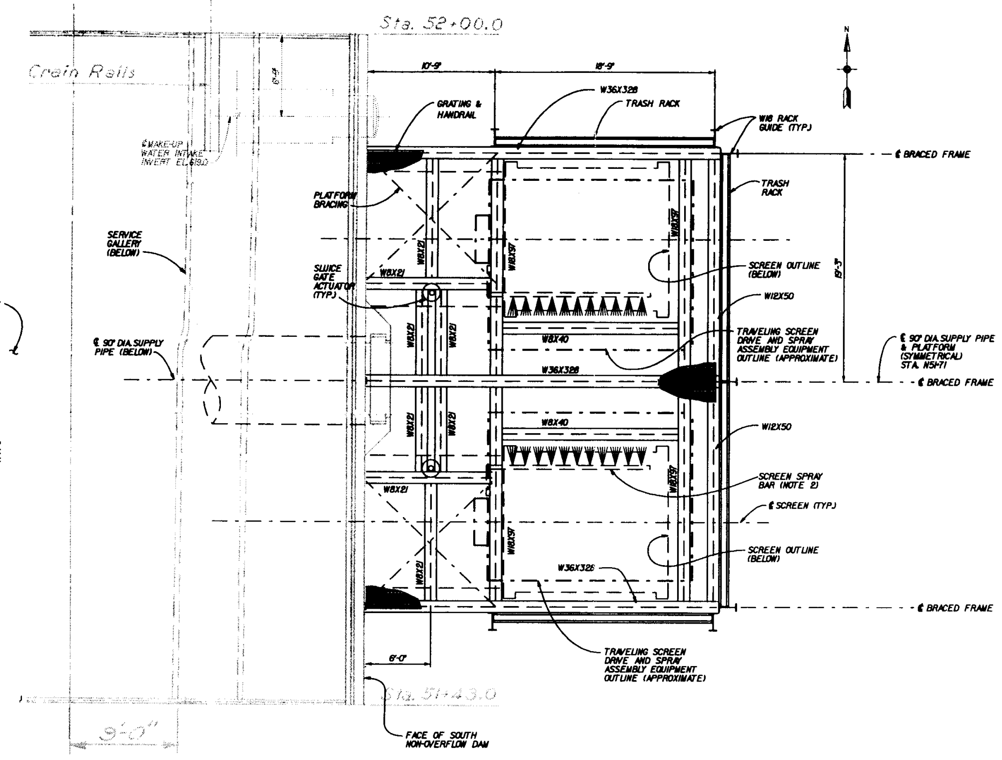
SOUTH NON-OVERFLOW DAM - SECTION

SCALE AS SHOWN | INV. NO.

PLATE 1.1.2



PLAN - EL. 610.0
SCALE IN FEET



PLAN - EL. 651.0
SCALE IN FEET

LEGEND:
NEW CONSTRUCTION
EXISTING

NOTE:
1. REMOVE CONCRETE GUIDE LOCALLY AT PIPE PENETRATION
2. DISCHARGE FROM SCREEN SPRAY SYSTEM TO BE ROUTED BACK TO FOREBAY. PIPING NOT SHOWN

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

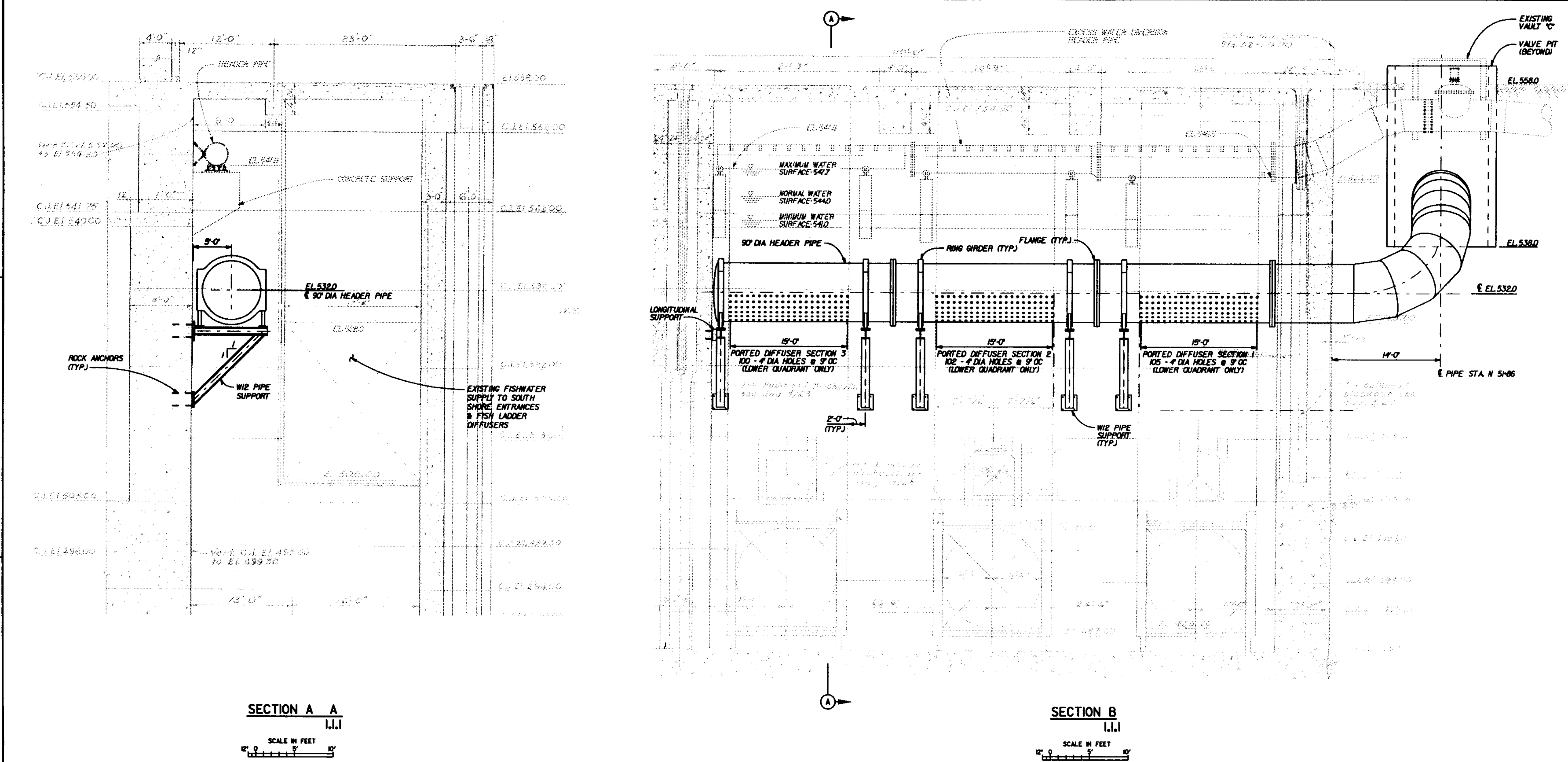
EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE I
FOREBAY INTAKE - PLANS

DESIGNED BY RBW
DRAWN BY GWS
CHECKED BY SWT

SCALE AS SHOWN | INV. NO.

PLATE 1.1.3

COMPUTER AIDED DESIGN & DRAFTING



LEGEND:

- NEW CONSTRUCTION
- EXISTING

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

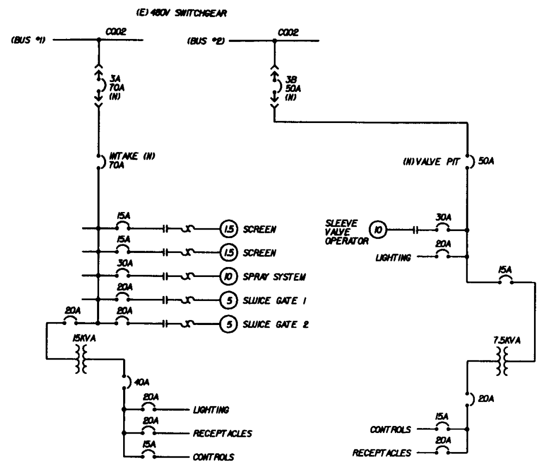
EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE I
PUMP CHAMBER - SECTIONS

RGM DESIGNED BY
DAP DRAWN BY
SWT CHECKED BY

COMPUTER AIDED DESIGN & DRAFTING

SCALE AS SHOWN | INV. NO.

PLATE 1.1.4



ONE LINE DIAGRAM

NOTES:

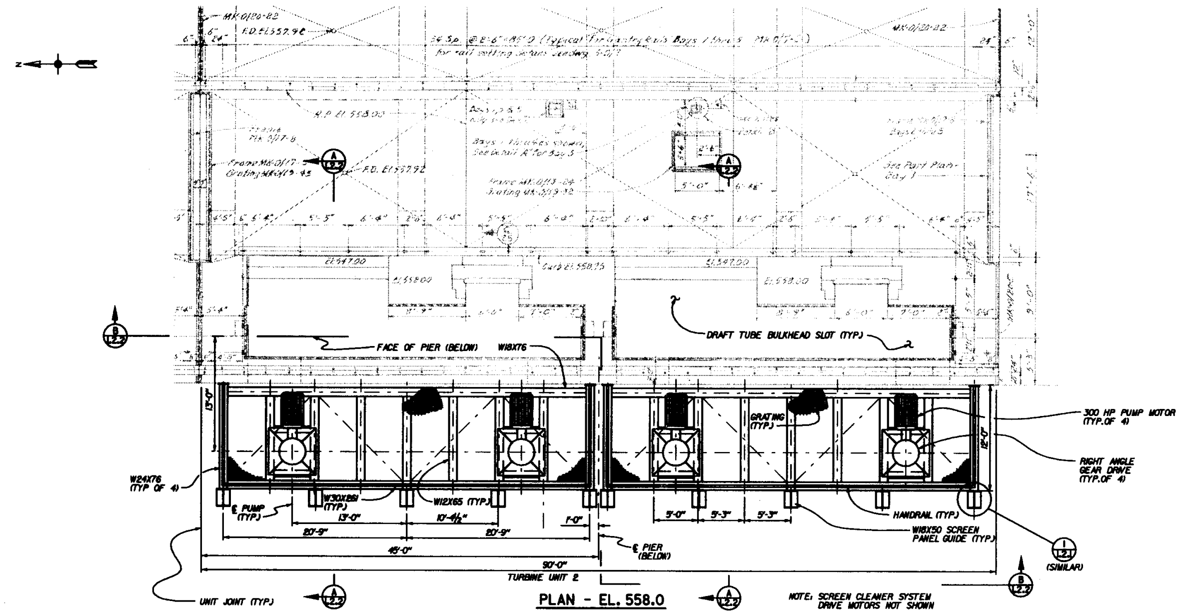
1. REFERENCE DRAWING LGP-LI-6-ID21/2

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DESIGNED BY: DA/RGW; DRAWN BY: SFD; CHECKED BY: DMT	LITTLE GOOSE LOCK AND DAM SNAKE RIVER, OREGON, WASHINGTON AND IDAHO EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE I ELECTRICAL ONE-LINE DIAGRAM
	SCALE AS SHOWN | INV. NO.
	PLATE I.I.5

COMPUTER AIDED DESIGN & DRAFTING

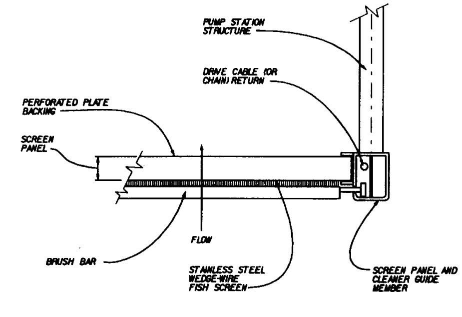
CONT. NO.

CORPS OF ENGINEERS — SAFETY PAYS — U. S. ARMY



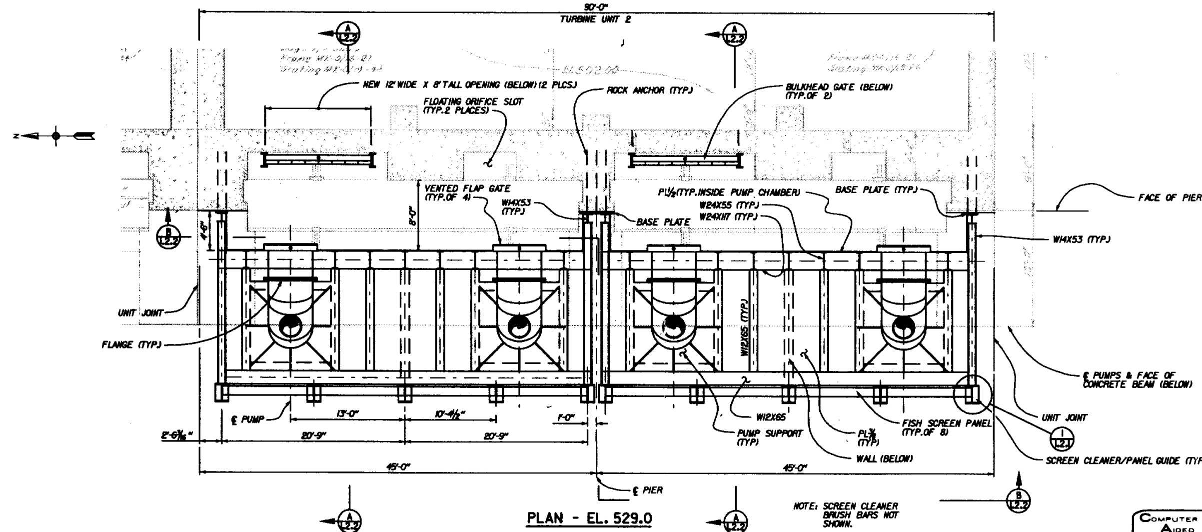
PLAN - EL. 558.0

SCALE IN FEET



TYPICAL BRUSH BAR GUIDE - PLAN 1/1.2.1

SCALE IN FEET



PLAN - EL. 529.0

SCALE IN FEET

LEGEND:

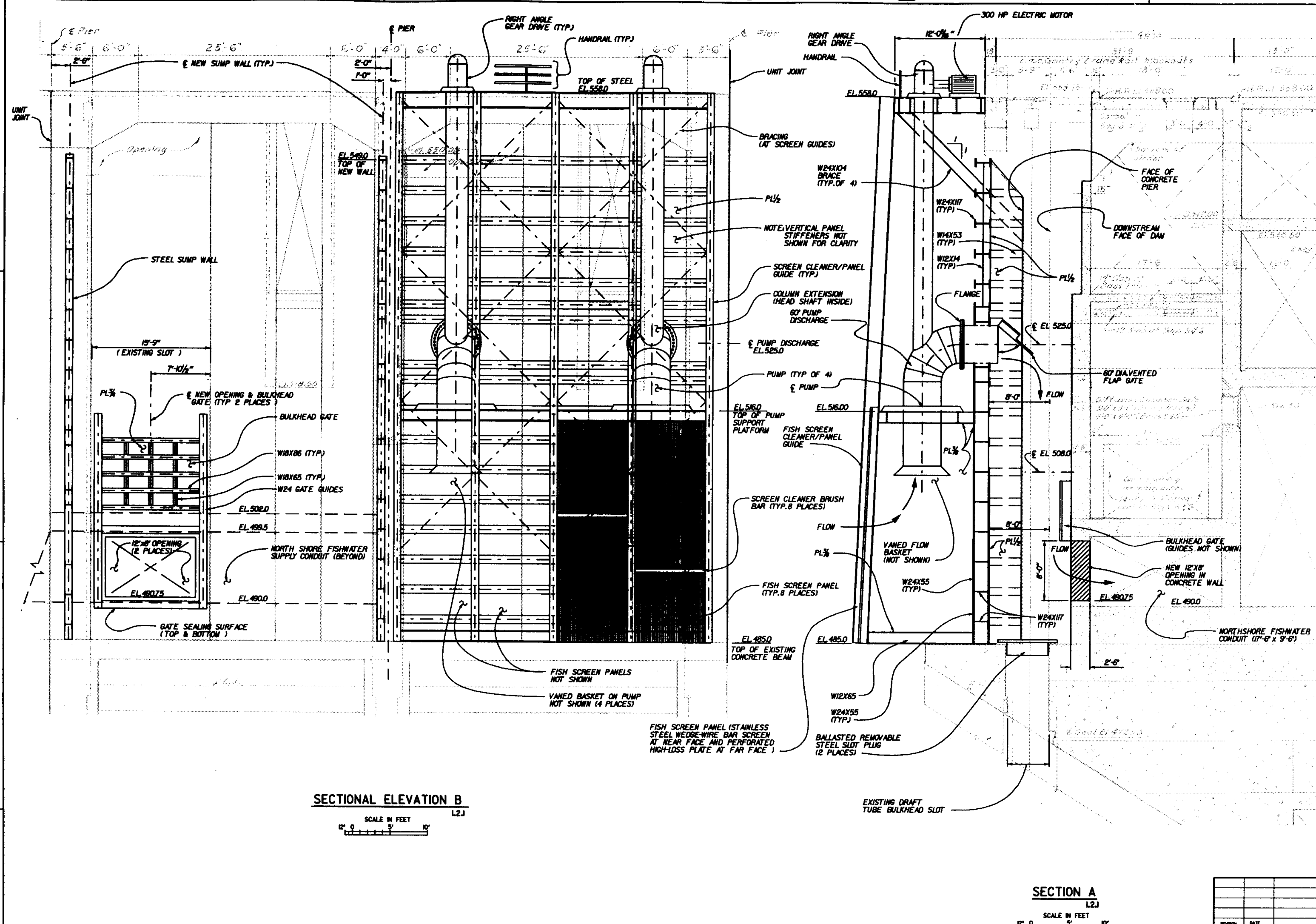
- NEW CONSTRUCTION
- EXISTING

COMPUTER AIDED DESIGN & DRAFTING

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DESIGNED BY RGW; DRAWN BY SFD; CHECKED BY SWT	LITTLE GOOSE LOCK AND DAM SNAKE RIVER, OREGON, WASHINGTON AND IDAHO EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 2 UNIT 2 TAILRACE - PLANS
	SCALE AS SHOWN — INV. NO.
	PLATE 1.2.1

VALUE ENGINEERING PAYS

CONT. NO.



LEGEND:

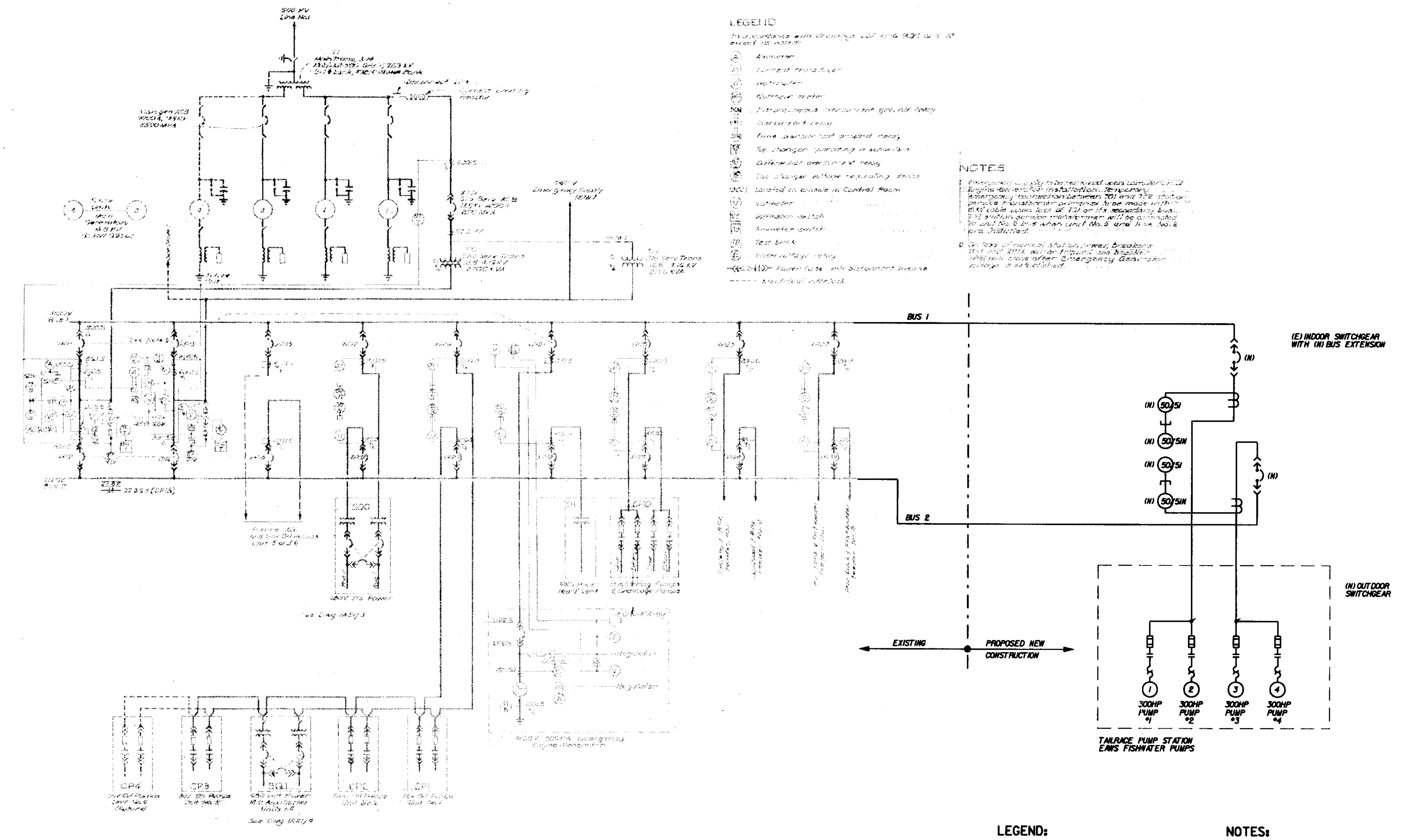
- NEW CONSTRUCTION
- EXISTING

COMPUTER AIDED DESIGN & DRAFTING

Sverdrup CIVIL, INC	U.S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DESIGNED BY: RGW	LITTLE GOOSE LOCK AND DAM
DRAWN BY: SFD	SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
CHECKED BY: SWT	EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 2
	PUMP STATION - ELEVATION & SECTION
	SCALE AS SHOWN | INV. NO.
	PLATE I.2.2

CONT. NO.

CORPS OF ENGINEERS SAFETY PAYS U. S. ARMY



ONE-LINE DIAGRAM
STATION SERVICE

LEGEND:

NEW CONSTRUCTION

EXISTING

NOTES:

1. REFERENCE DRAWING, LGP-1J-6-1A21/2

COMPUTER AIDED DESIGN & DRAFTING

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE 2
ELECTRICAL ONE-LINE DIAGRAM

DA/BGW
SFD
DMT

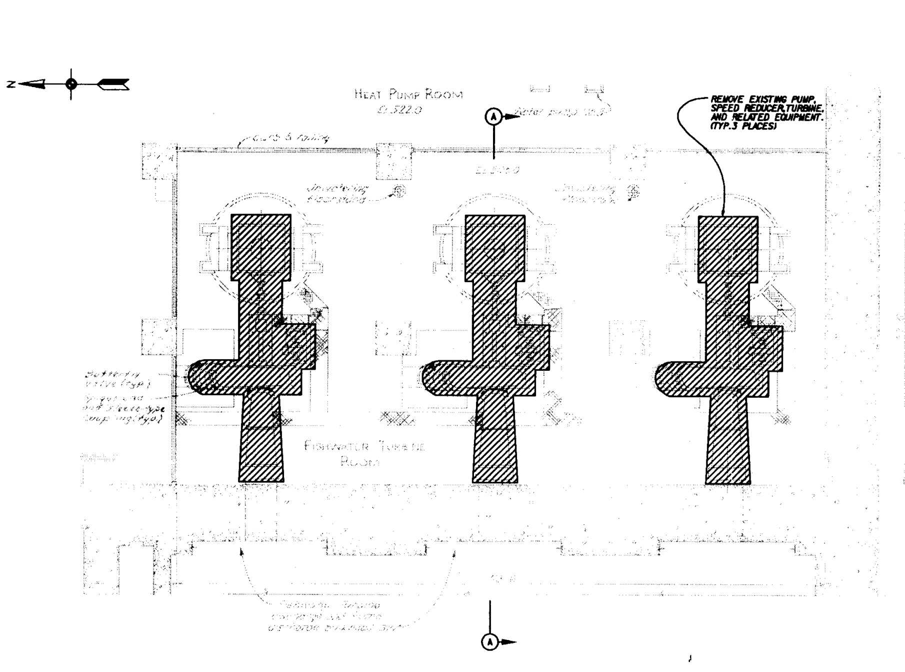
SCALE AS SHOWN | INV. NO.

PLATE 1.2.3

VALUE ENGINEERING PAYS

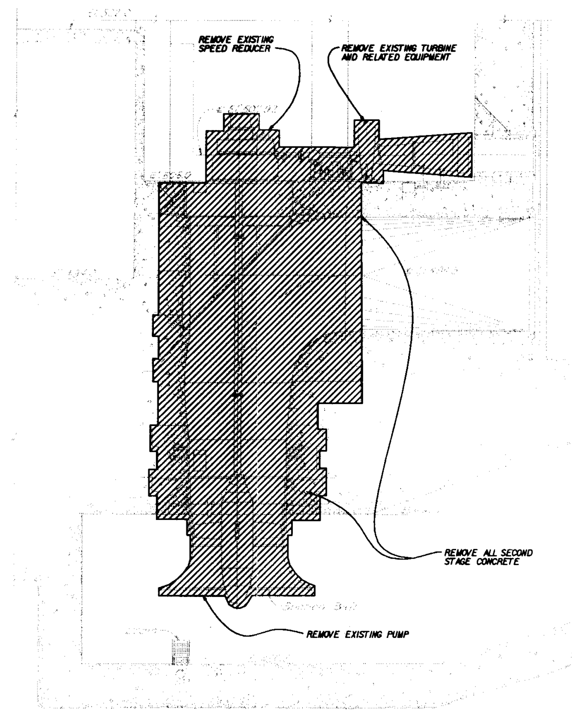
CONT. NO.

CORPS OF ENGINEERS   SAFETY PAYS   U. S. ARMY



DEMOLITION PLAN

SCALE IN FEET



SECTION A

SCALE IN FEET

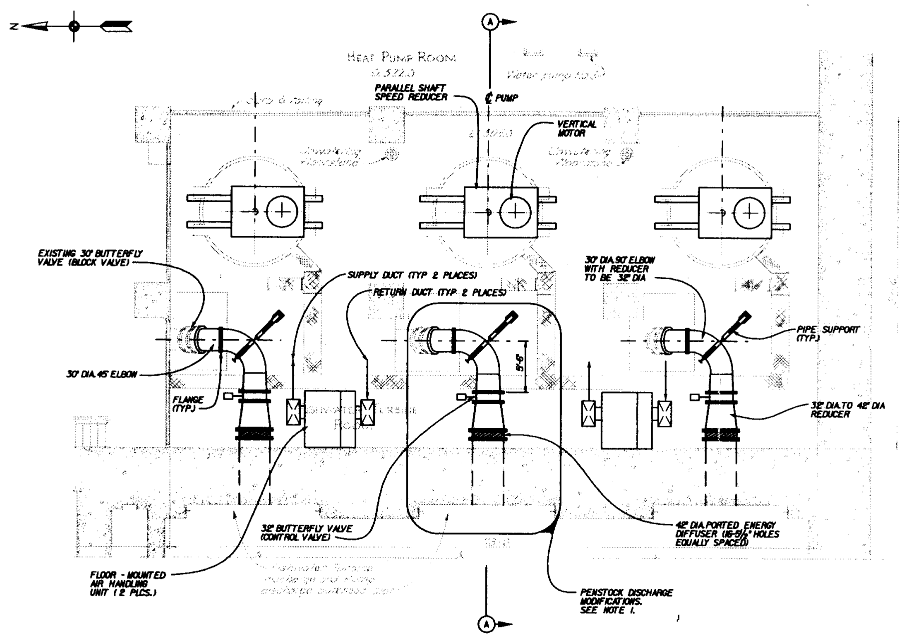
LEGEND:

- NEW CONSTRUCTION
- EXISTING
- ITEMS TO BE REMOVED.

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DESIGNED BY GBM/RGM	LITTLE GOOSE LOCK AND DAM SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
DRAWN BY SFD	EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 3
CHECKED BY ALN	AWS PUMPHOUSE - DEMOLITION PLAN & SECTION
	SCALE AS SHOWN | INV. NO.
	PLATE I.3.1

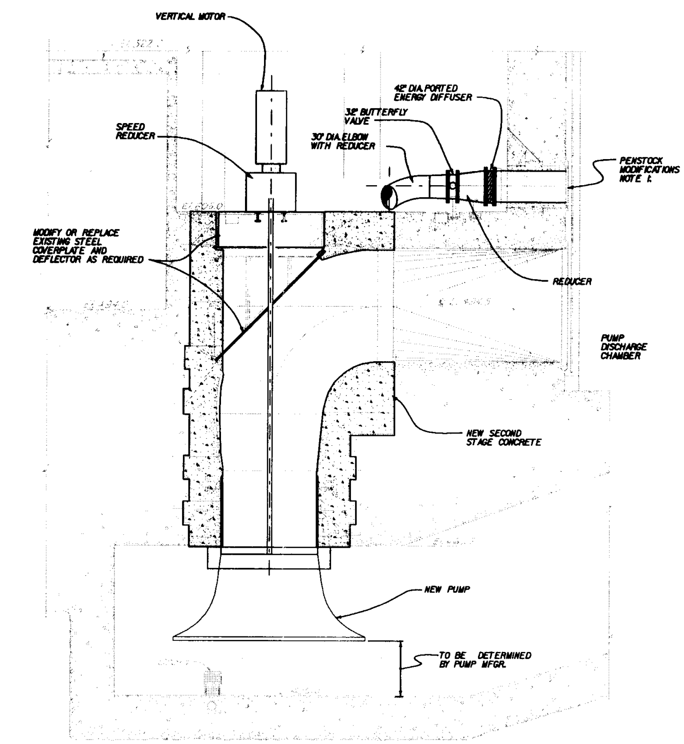
COMPUTER AIDED DESIGN & DRAFTING

VALUE ENGINEERING PAYS   CONT. NO.



FISHWATER PUMP ROOM - PLAN

SCALE IN FEET 12" 0 5' 10'



SECTION A

SCALE IN FEET 12" 0 5' 10'

LEGEND:

——— NEW CONSTRUCTION

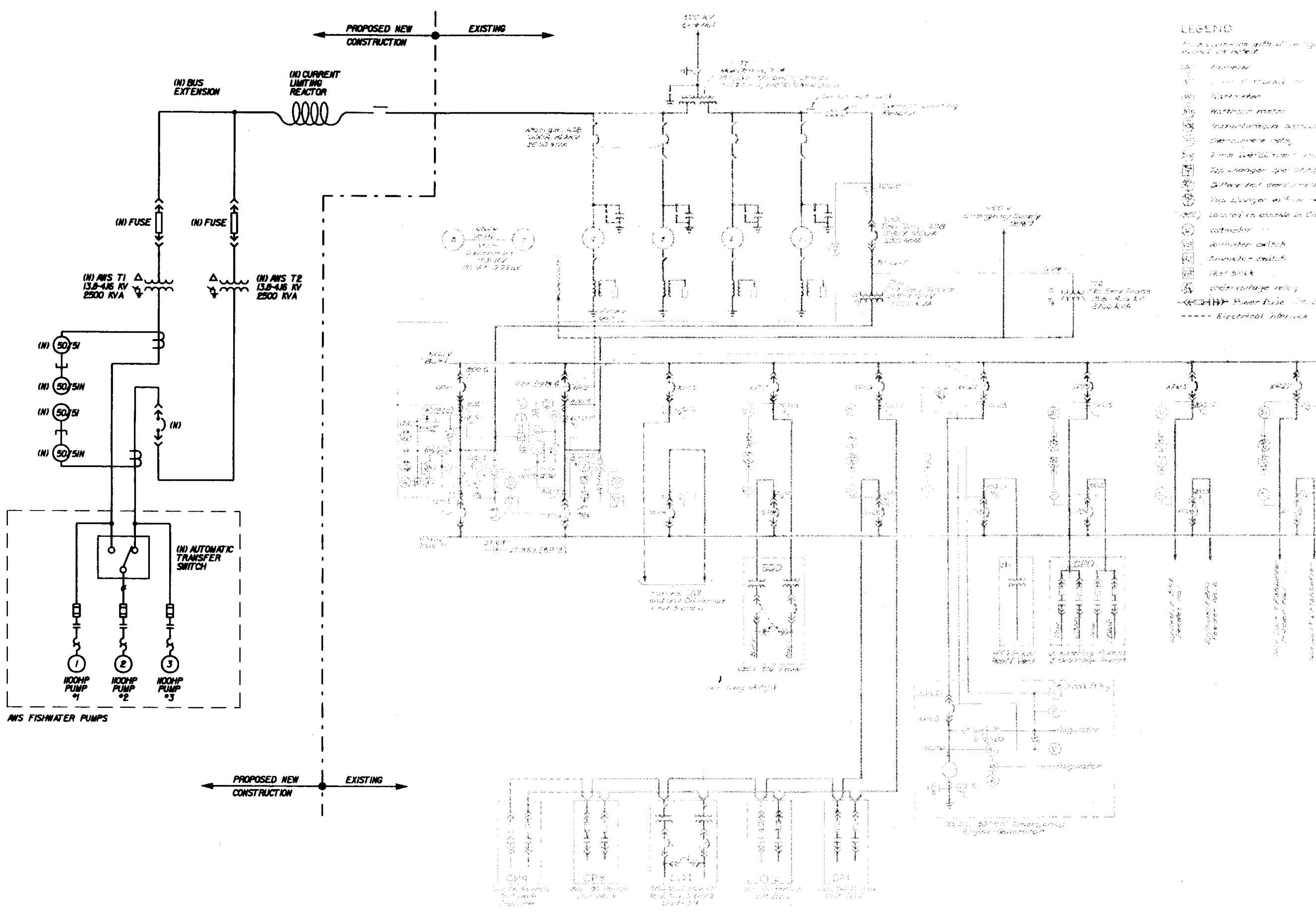
.... EXISTING

NOTES:

1. MODIFICATIONS AT PENSTOCK DISCHARGE ARE APPLICABLE FOR ALTERNATIVE 3 - OPTION 2 ONLY. FOR OPTION 1, PENSTOCK WOULD BE BLIND FLANGED AT THE EXISTING 30" BUTTERFLY VALVE AND AT THE FLEXIBLE COUPLING AT THE WALL.

COMPUTER AIDED DESIGN & DRAFTING

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
GBW/RGW DESIGNED BY; SFD DRAWN BY; ALH CHECKED BY	LITTLE GOOSE LOCK AND DAM SNAKE RIVER, OREGON, WASHINGTON AND IDAHO EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 3 AWS PUMPHOUSE - PLAN AND SECTION
	SCALE AS SHOWN / INV. NO.
	PLATE I.3.2



LEGEND:

— NEW CONSTRUCTION

····· EXISTING

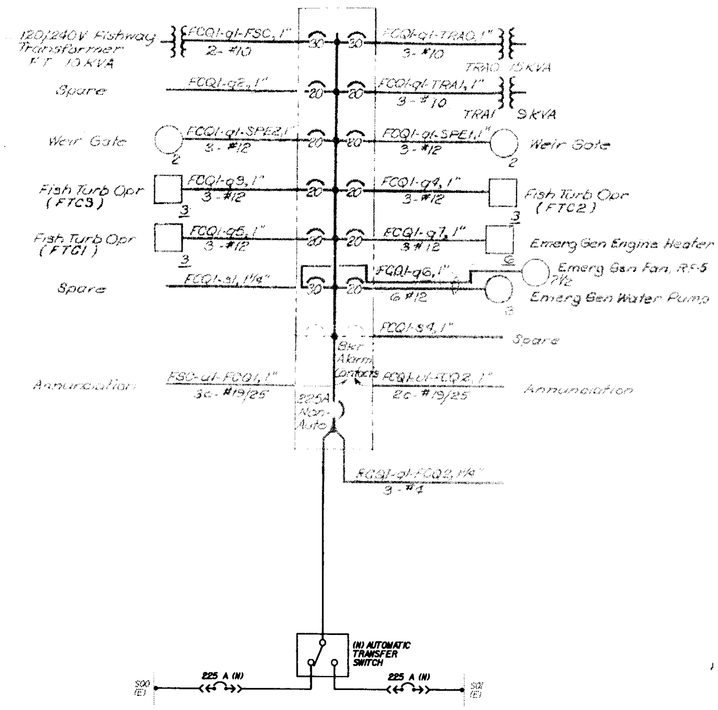
NOTES:

1. REFERENCE DRAWING LGP-11-6-1A21/2

ONE-LINE DIAGRAM
STATION SERVICE

Sverdrup CIVIL, INC	U.S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DA/RGW DESIGNED BY	LITTLE GOOSE LOCK AND DAM
SFD DRAWN BY	SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
DMT CHECKED BY	EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 3 ELECTRICAL ONE-LINE DIAGRAM
	SCALE AS SHOWN
	PLATE 1.3.3

COMPUTER AIDED DESIGN & DRAFTING



ONE-LINE DIAGRAM
FCQ1 SWITCHGEAR

LEGEND:

NEW CONSTRUCTION

EXISTING

NOTES:

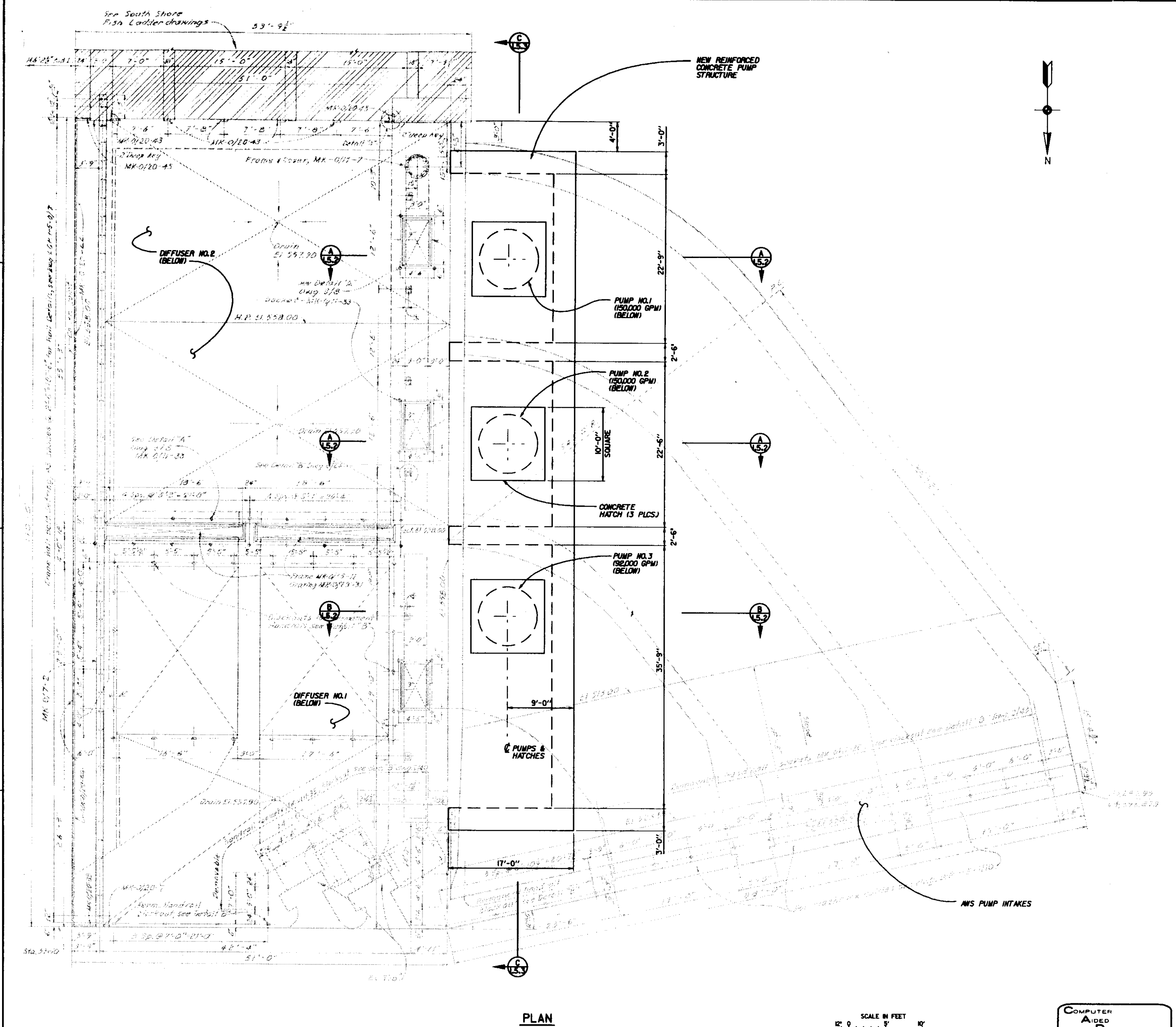
1. REFERENCE DRAWING LGP-LI-6-1D21/2

COMPUTER AIDED DESIGN & DRAFTING

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DA/BGW DESIGNED BY	LITTLE GOOSE LOCK AND DAM
SFD DRAWN BY	SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
DMT CHECKED BY	EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 4 ELECTRICAL ONE-LINE DIAGRAM
	SCALE AS SHOWN INV. NO.
	PLATE 1.4.1

CONT. NO.

CORPS OF ENGINEERS — SAFETY PAYS — U. S. ARMY



LEGEND:

NEW CONSTRUCTION

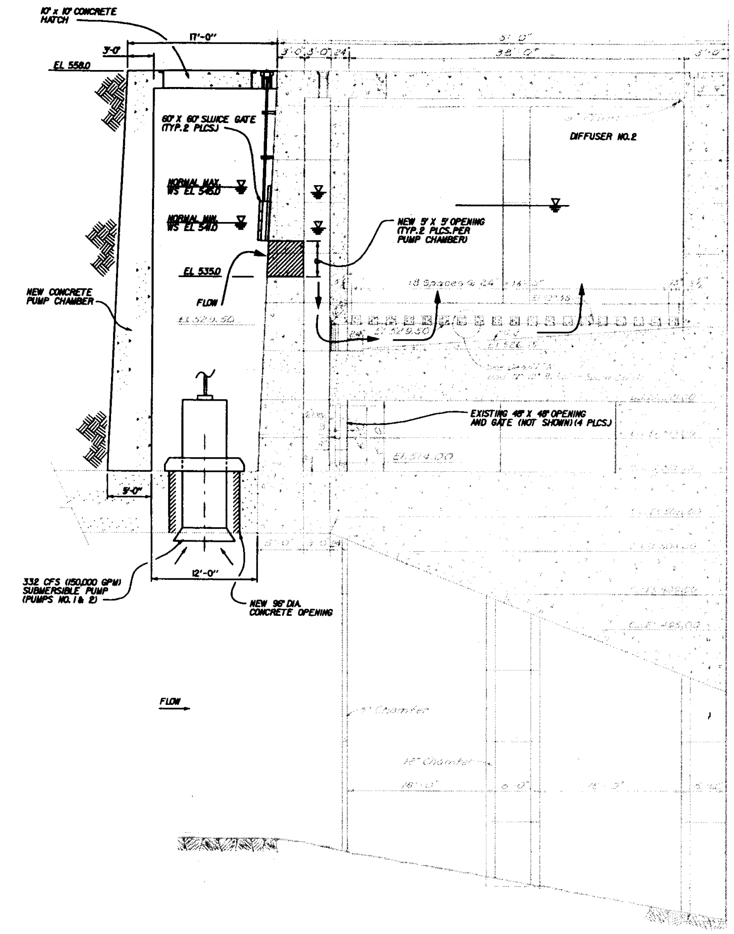
EXISTING

Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
RGW / SFD / SMT	LITTLE GOOSE LOCK AND DAM SNAKE RIVER, OREGON, WASHINGTON AND IDAHO EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 5 AWS PUMP INTAKE - PLAN
	SCALE AS SHOWN — INV. NO.
	PLATE 1.5.1

COMPUTER AIDED DESIGN & DRAFTING

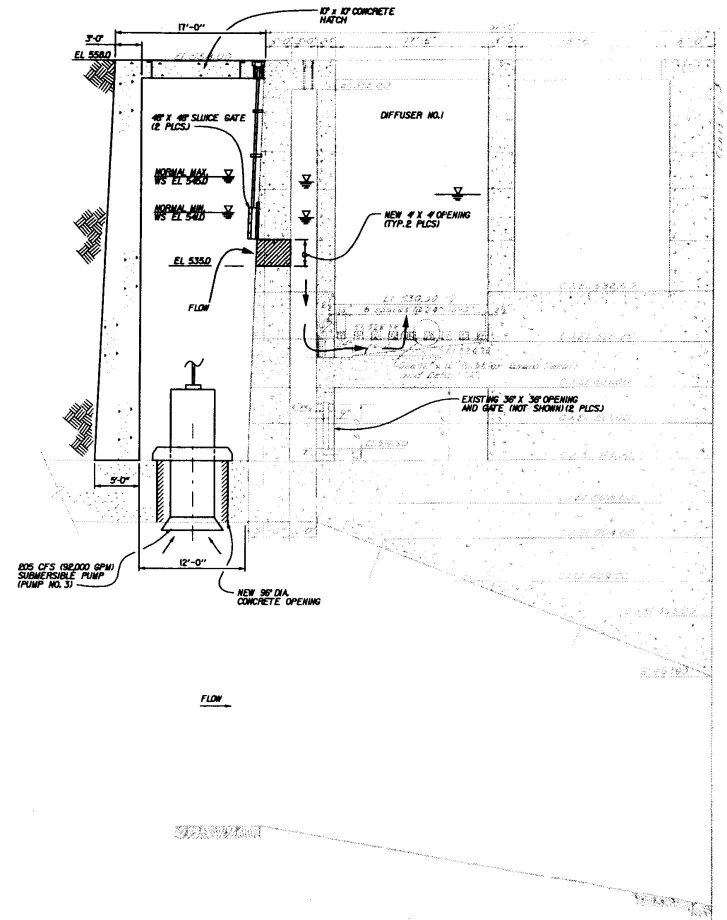
VALUE ENGINEERING PAYS

CONT. NO.



SECTION A
1.5.1

SCALE IN FEET 12" 0 5' 10'



SECTION B
1.5.1

SCALE IN FEET 12" 0 5' 10'

LEGEND:
- NEW CONSTRUCTION
- EXISTING

Computer Aided Design & Drafting

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

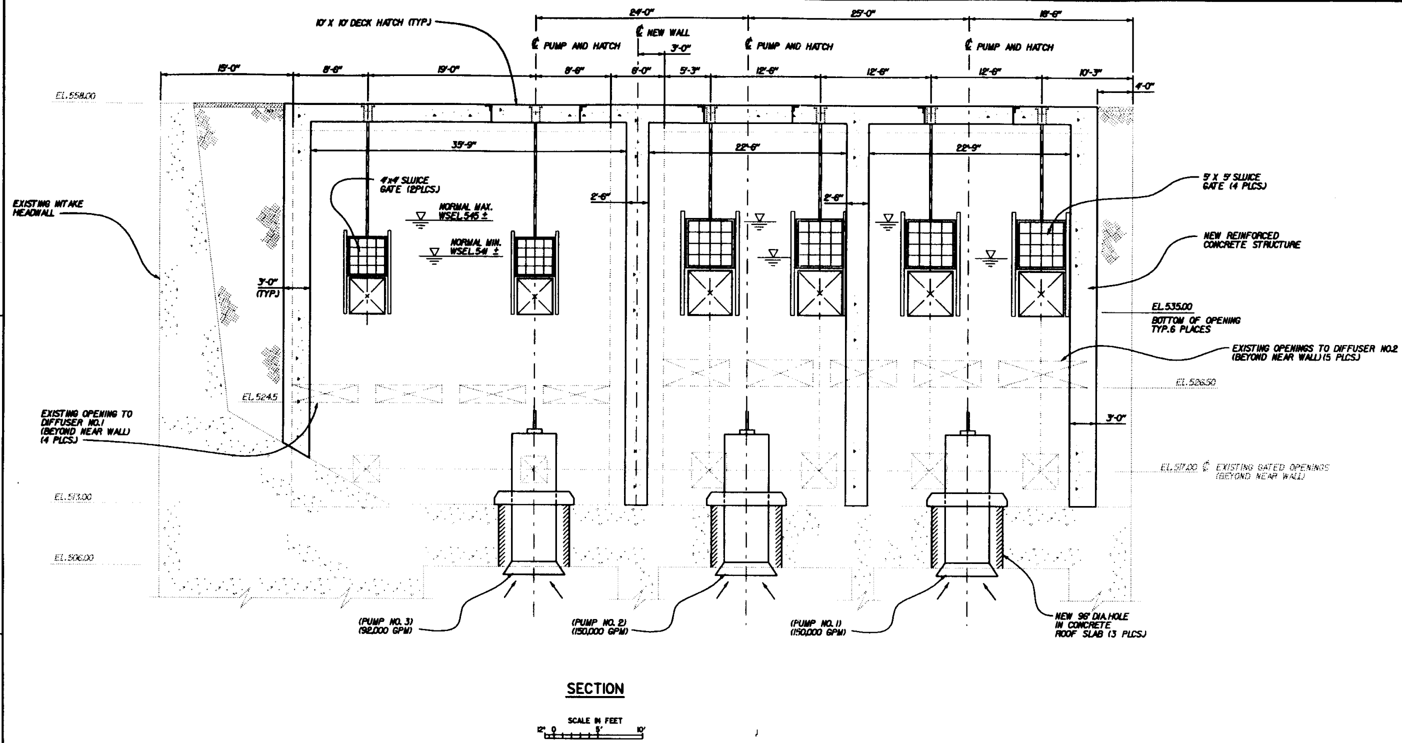
RGW DESIGNED BY
SFD DRAWN BY
SWT CHECKED BY

LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE 5
AWS PUMP INTAKE - SECTIONS

SCALE AS SHOWN | INV. NO.

PLATE 1.5.2

CONT. NO.



SECTION

LEGEND:

——— NEW CONSTRUCTION

······· EXISTING

Sverdrup CIVIL, INC.

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LITTLE GOOSE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE 5
AWS PUMP INTAKE - SECTIONS

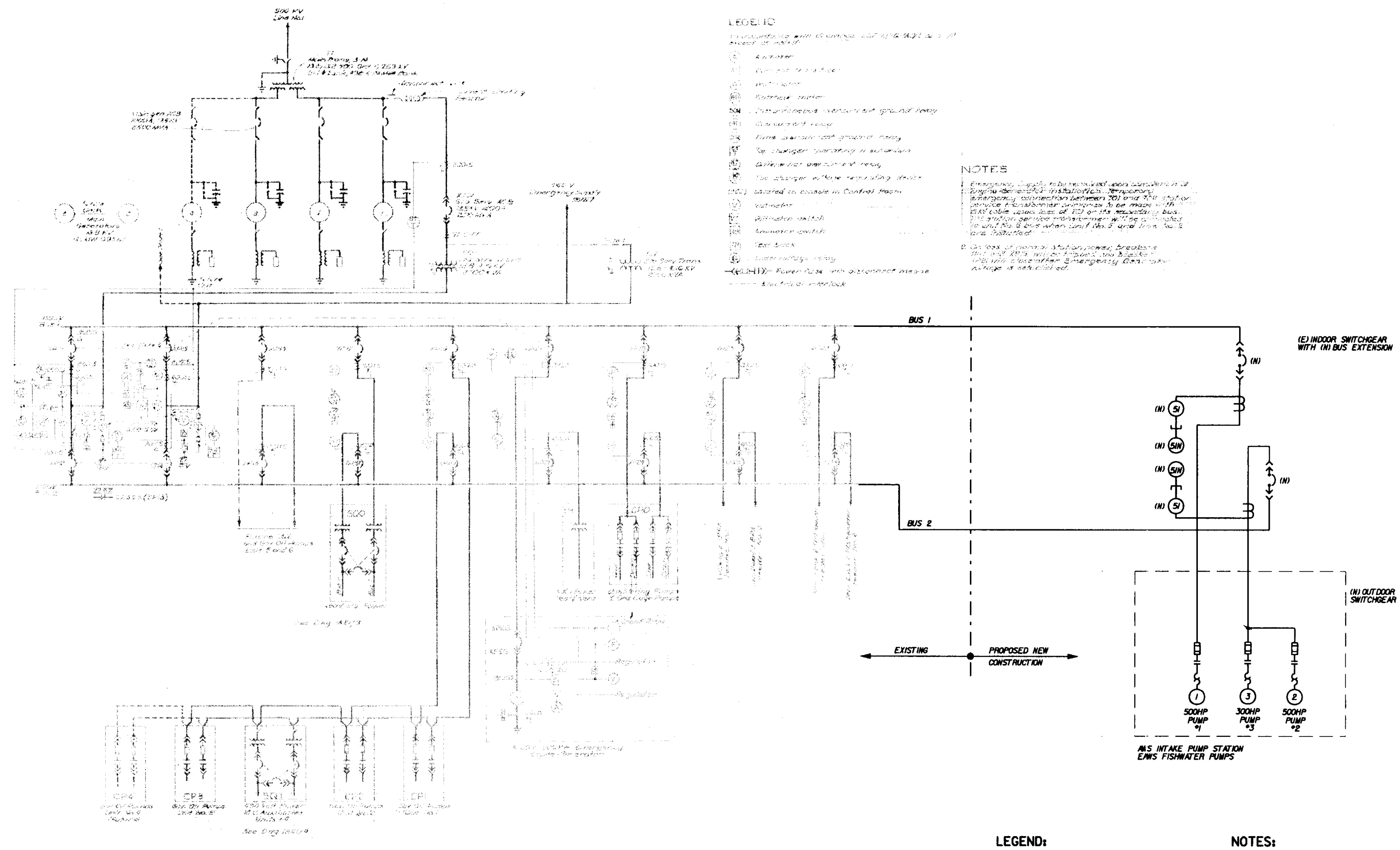
DESIGNED BY: RGM
DRAWN BY: SFD
CHECKED BY: SMT

SCALE AS SHOWN | INV. NO.

PLATE I.5.3

COMPUTER AIDED DESIGN & DRAFTING

CORPS OF ENGINEERS — SAFETY PAYS — U. S. ARMY



ONE-LINE DIAGRAM
STATION SERVICE

LEGEND:

- NEW CONSTRUCTION
- EXISTING

NOTES:

1. REFERENCE DRAWING. LGP-L1-6-1A21/2

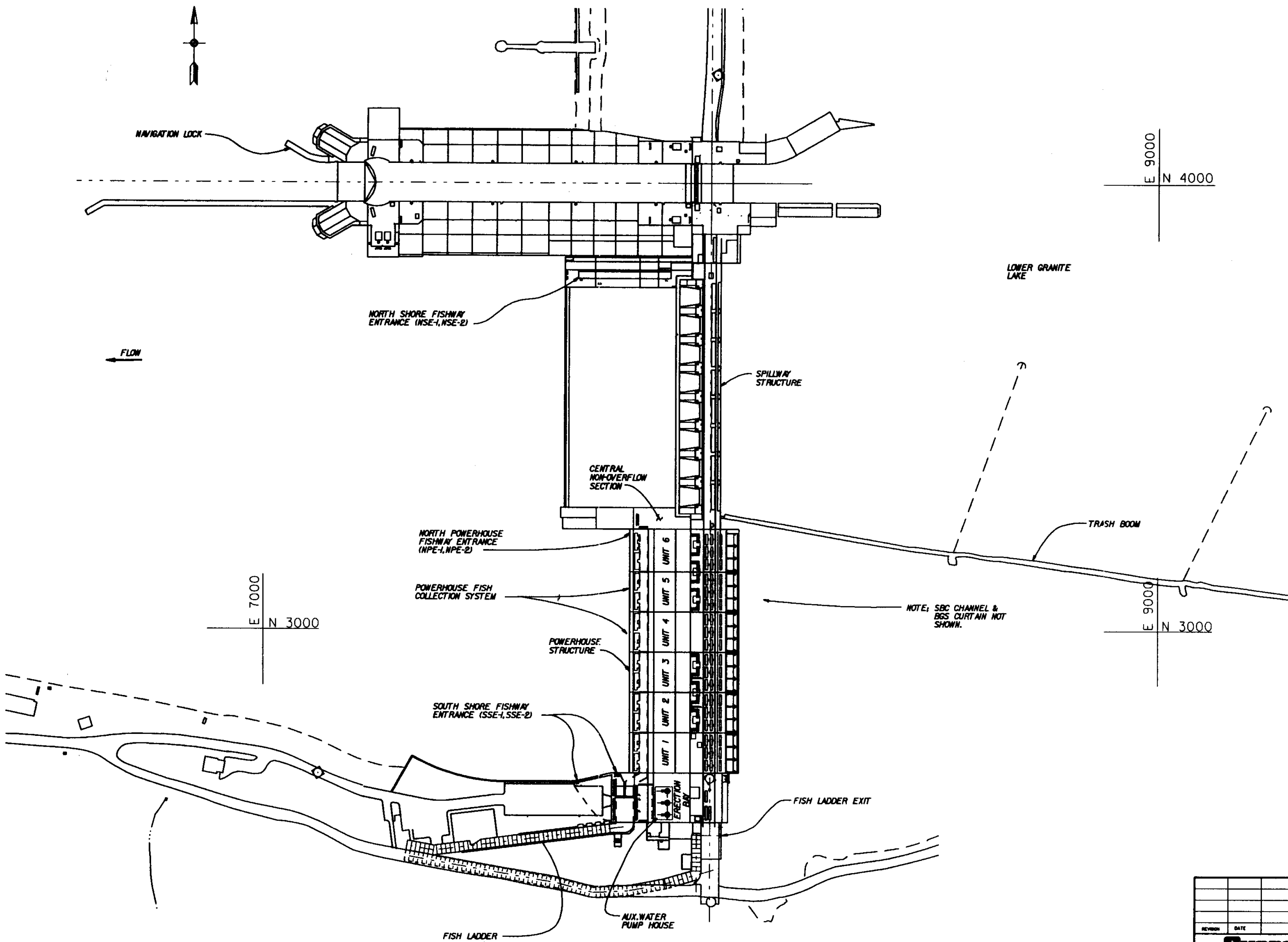
Sverdrup CIVIL, INC	U. S. ARMY ENGINEER DISTRICT WALLA WALLA, WASHINGTON
DA/BGW (DESIGNED BY)	LITTLE GOOSE LOCK AND DAM
SFD (DRAWN BY)	SNAKE RIVER, OREGON, WASHINGTON AND IDAHO
DMT (CHECKED BY)	EMERGENCY AUXILIARY WATER SUPPLY ALTERNATIVE 5 ELECTRICAL ONE-LINE DIAGRAM
	SCALE AS SHOWN — INV. NO.
	PLATE 1.5.4

COMPUTER AIDED DESIGN & DRAFTING

VALUE ENGINEERING PAYS

CONT. NO.

CORPS OF ENGINEERS SAFETY PAYS U. S. ARMY



LOWER GRANITE LOCK AND DAM

SCALE IN FEET
100' 0 100'

COMPUTER AIDED DESIGN & DRAFTING

REVISION	DATE	DESCRIPTION	CHKD.	APPR.

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

EMERGENCY AUXILIARY WATER SUPPLY

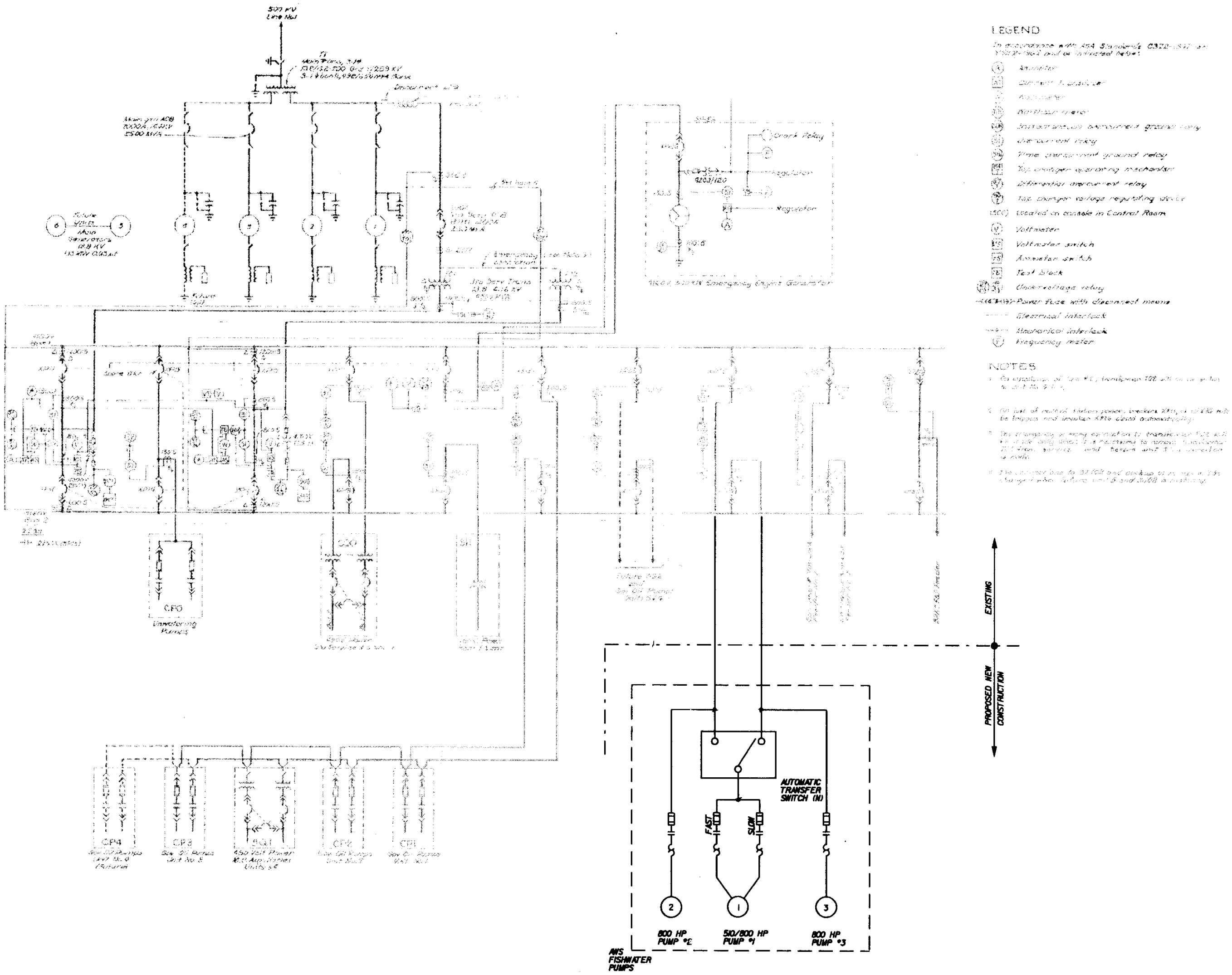
SITE PLAN

DESIGNED BY: RGW
DRAWN BY: SFD
CHECKED BY: SWT

SCALE AS SHOWN | INV. NO.

PLATE 2.1

VALUE ENGINEERING PAYS CONT. NO.



ONE - LINE DIAGRAM
STATION SERVICE

LEGEND:

NEW CONSTRUCTION

EXISTING

NOTES:

1. REFERENCE DRAWING GDP-1-6-1A21/2

REVISION	DATE	DESCRIPTION	CHKD.	APPR.

Sverdrup CIVIL, INC

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON AND IDAHO

EMERGENCY AUXILIARY WATER SUPPLY
ALTERNATIVE I
ELECTRICAL ONE-LINE DIAGRAM

DESIGNED BY: DA/BBW
DRAWN BY: SFD
CHECKED BY: DMT

SCALE AS SHOWN | INV. NO.

PLATE 2.1.1

COMPUTER AIDED DESIGN & DRAFTING

CONT. NO.

APPENDIX A

Quality Control Plan
And
Independent Technical Reviews (ITR)

PROJECT QUALITY CONTROL PLAN WORKSHEET

PROJECT:	**Little Goose / Lower Granite Dams** I.D. **3.06.01.2**	DATE QCP PREPARED:	**8-Mar-00**
JOB TITLE:	**Emergency Water Eastern Projects - Tech Report**	QCP PREPARER:	**Rolf G. Wielick, Sverdrup**
TYPE OF DOCUMENT:	**Technical Report** Est. Const. Cost: **(TBD)**	ITR PERFORMED by:	**Sverdrup**
DESCRIPTION / SCOPE:	**See Attached Documentation**	BUDGET for ITR:	**$33,830**
DATE ITR COMPLETED:	**28-Sep-00**	ACTUAL COST of ITR:	

PRODUCT TEAM

NAME	GRADE	DISCIPLINE	COMPANY or OFFICE
Rolf G. Wielick, PE	P5	Project Manager	Sverdrup
Steve Wittmann-Todd, PE	P5	Structural	Sverdrup
Angela S. Brady, PE	P2	Structural	Sverdrup
David E. Hackman, PE	P6	Electrical	Sverdrup
Sean F. Dzuiba	T3	CADD	Sverdrup
David A. Allison, EIT	P2	Civil	Sverdrup
Gerald B. Walker, PE	Sr. Engr.	Mechanical	DCV Consult.
David F. Absher, PE	Sr. Engr.	Electrical	DCV Consult.
Perry Johnson, PE	P-13	Hydraulics	ENSR

ITR REVIEW TEAM

NAME	GRADE	DISCIPLINE	COMPANY or OFFICE
M. Reece Voskuilen, PE	P6	Mechanical	Sverdrup
Kelly B. Freeman, PE, SE	P6	Structural	Sverdrup
Aaron L. Newman, PE	Sr. Engr.	Mechanical	DCV Consult.
David M. Thomas, PE	Sr. Engr.	Electrical	DCV Consult.
Mizan Rashid, PE, PhD	P-11	Hydraulics	ENSR

MAJOR PRODUCT MILESTONES

ITEM	DATE
Notice to Proceed	2/21/00
Site Visit (Lower Granite/Little Goose Dams)	2/29/00
Codes and Standards Submittal	3/6/00
Quality Control Plan Submittal	3/22/00
30% Submittal	5/2/00
60% Submittal	6/29/00
100% Submittal (Incl. DDR)	8/30/00
Final Submittal (Incl. DDR)	9/28/00

IN-PROGRESS REVIEWS

ITEM	DATE
60% ITR Submittal (SOW Items 5.8.a & b only)	7/13/00
100% ITR Submittal (SOW Items 5.8.a & b only)	9/13/00
Final ITR Submittal (SOW Items 5.8.c & d)	9/28/00

STATEMENT OF TECHNICAL REVIEW
COMPLETION OF INDEPENDENT TECHNICAL REVIEW

The Sverdrup Civil, Inc. and its subconsultants ENSR Corporation and DCV Consultants have completed the Independent Technical Review of the Little Goose/Lower Granite EAWS Phase II Technical Report (DACW68-99-D-0003, Task Order No. 1). Notice is hereby given that an Independent Technical Review (ITR) has been conducted, that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the ITR, compliance with established policy principles and procedures utilizing justified and valid assumptions was verified. This included: review of assumptions methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customers' needs consistent with law and existing Corps policy. The ITR was accomplished by Sverdrup Civil, Inc. and its subconsultants ENSR Corporation and DCV Consultants.

Marin R. Voskuilen 9/29/00

Marinus R. Voskuilen, PE
Technical Review Team Leader

Date

Review Team Members

Kelly B. Freeman, PE Sverdrup Civil, Inc.	Aaron L. Newman, PE DCV Consultants
Marinus R.(Reece) Voskuilen, PE Sverdrup Civil, Inc.	David M. Thomas, PE DCV Consultants
Mizan Rashid, PE, PhD ENSR	

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW

Technical concerns and the explanation of the resolution are attached:

As noted above, all concerns resulting from independent technical review of the project have been considered. The report and all associated documents required by the National Environmental Policy Act have been fully reviewed or are not applicable.

Glen M. Aurdahl 9/29/00

Glen M. Aurdahl, PE
Sverdrup Civil, Inc. Hydro/Fisheries
Section Manager

Date

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 11, 2000 | **Reviewer:** Mizan Rashid | **Telephone:** (425) 881-7700

___	CENW____		**Design Document**				**Discipline**
___	Air Force	___	D. Memo	___	Concept	___	Architect
___	Army	X	ITR P&S	___	Prelim.	___	Civil
X	Consultant	___	30%	___	Final	___	Mech/Elec.
___	Other	X	60%	___	BCOE	___	Structural
						X	Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**; **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Perry Johnson

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check
1	General Comment	It is important to supplement the flow in a fish ladder with similar quality of water (constituent and temperature) as compare to the main ladder flow (through the ladder exit). A discussion on consistency in the quality of water in the fish ladder from various sources would be helpful. It may not be possible to have the same quality of water from all the sources (ladder exits, gravity and pumped) but we should at least address the issue in the report. If there are differences in temperature and turbidity, it would be beneficial to know those differences, since significant differences may result in delay in fish migration.	**A** – A discussion will be added to the text that addresses this issue. The discussion will include comparison to the current conditions and will note the run-of-the-river nature of the reservoir (relatively weak stratification).	**C**	MR
2	Page 4-16, first paragraph	Given the differential head across the header pipe in the pump discharge chamber, significant refinement in port size and spacing would be required to achieve a reasonable distribution of flow through various ports.	**A** – Differential across the header (ported diffuser) will be approximately 40-ft with maximum axial velocities of 20 ft/s. Relative velocity influences on differential are small, with influences on discharge distribution being smaller yet (the square root of the differential). These influences have been considered in development of the design.	**NA**	MR
3	Page 4-17, flow control and Air/Vacuum Release Equipment	Part 1: Even though the butterfly valve will provide adequate flow control over the range of flow and static head, for the sake of safety and ease of maintenance of the gravity flow system including the butterfly valve itself, an alternate flow control may be desirable. How about considering a flow control	**A** – Sluice gates have been included on the supplies to the 90-inch line from each traveling screen (Plate 1.1.3).	**C**	MR

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 11, 2000	**Reviewer:** Mizan Rashid	**Telephone:** (425) 881-7700	
___ CENW___	**Design Document**		**Discipline**
___ Air Force	___ D. Memo	___ Concept	___ Architect
___ Army	X ITR P&S	___ Prelim.	___ Civil
X Consultant	___ 30%	___ Final	___ Mech/Elec.
___ Other	X 60%	___ BCOE	___ Structural
			X Hydraulic

Item No.	Dwg. Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Perry Johnson		
		gate at the entrance to the 90-inch conduit near the forebay intake. Part 2: If this option is selected for final design, a surge analysis should be performed to identify the maximum and minimum pressure in the entire gravity flow system. This analysis should address the appropriate specification and location of air/vacuum release valves in order to keep the system pressure during extreme operating conditions, i.e., valve closure/opening, conduit filling and draining etc.	The sluice gates allow both isolation and emergency closure. Combined air/vacuum relief valves have been supplied. We agree that a surge analysis should be conducted in support of a final design. This requirement will be noted in the text.		
4	Page 4-15, 3rd paragraph from top	The concept of field calibration of the control valve seems a better option. If this option is selected, the method of field calibration should be specified.	**A** – Agree. Additional support text will be added.	**C**	MR
5	Page 4-25, 3rd paragraph from top	Part 1: Smaller trash will accumulate in the vane basket. The cleaning issue should be addressed in this report. Part 2: Even though maintaining a depth to spacing ratio at or greater than one for both the vanes and grating would help breaking the incoming vortices, complete dissipation of any such vortices would also be a function of the strength of the vortex. In addition to providing the vane basket, we should think about preventing vortices from forming in the vicinity of the cage in the first place. Using the experience from other similar pump station design, it would be possible to install fillets in the pump intake to minimize the potential of vortex formation. I do not think designing fillets is necessary at 60% level.	**A** – Agree. Text will be added to address both of these comments.	**NA** – Fish screens ahead of the pump intakes eliminate debris issues at the vaned baskets.	MR

Review Comments
Project: Emergency Aux. Water Supply - Independent Technical Review
Location: Little Goose/Lower Granite Locks and Dams

Date: July 11, 2000 | **Reviewer:** Mizan Rashid | **Telephone:** (425) 881-7700

		Design Document			Discipline
	CENW____				
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.		Civil
X	Consultant		30%		Final		Mech/Elec.
	Other	X	60%		BCOE		Structural
						X	Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)
DESIGN OFFICE: **C - Correction Made** (If not, explain)
Back Check By: (Initials)

Action taken on Comments by: Perry Johnson

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
6	A few editorial comments/typos	Page 4-14, 1st paragraph: 'three dimensional energy influences' – how about deleting the term 'three dimensional' Page 4-14, 2nd paragraph: 'approximately 0.125 ft' – how about just 0.1 ft Page4-14, 2nd paragraph: 'elevation 646.5 to elevation 646.5' – need a different lower range Page 4-21, last paragraph: 'about 180 cfs' – should it be 150 cfs instead to make a total of 850 cfs.	**A** – Agree, clarification will be added.	**C**	MR

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: June 29, 2000	**Reviewer:** Aaron Newman, P.E.		**Telephone:** (707) 763-7867	Page 1 of 2		
___ CENW____ ___ Air Force ___ Army X Consultant ___ Other	**Design Document** ___ D. Memo X ITR P&S ___ 30% X 60%	___ Concept ___ Prelim. ___ Final ___ BCOE	**Discipline** ___ Architect ___ Civil X Mech/~~Elec~~. ___ Structural ___ Hydraulic	**REVIEW CONFERENCE** **A - Comment Accepted** **W - Comment Withdrawn** (If neither , explain)	**DESIGN OFFICE** **C - Correction Made** (If not, explain)	Back Check By: (Initials)

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Action taken on Comments by:		
1	4.2.2.2 Page 4-6	Pump #1 vibration occurring at rotational frequency could be due to a bent shaft, an impeller out of balance if the bearings are very loose the bearings are very loose, or an impeller blade that is not pitched properly.	**A** – Good suggestions. We will point these possibilities out in final report.	**C**	ALN
2	4.3.2 Page 4-11	The installation of new turbines, gearboxes and pumps to replace the existing equipment that can provide the 3150 cfs should be considered. It should be determined if advances in pump design are sufficient to allow for a replacement in the existing physical envelope.	**A** – Investigation shows the penstocks are at or exceeding allowable velocities with current flow. Additional flow for more powerful turbines is not available. Pump vendors will be contacted if Alternate 3 goes forward.	**C**	ALN
3	4.6 Page 4-30	AWS Pumping Equipment Upgrade modifies the pumps upgrade addresses the change of pumps to electric drive and may or may not incorporate the use of water now available from the no-longer used turbine supply. A study of increasing the size of the pumps and using a more efficient turbine to meet the pump requirements may better meet the requirements. Can the system fit in the same footprint and meet the flow requirements? If the answer is yes then this modification may be viable.	**A** – See response to Item No. 2.	**C**	ALN
4	4.6 Page 4-32	Option 2, indicates that "pumps rated at 915 cfs would be required". The Sample Calculations Indicate that this should be 920 cfs.	**A** – 920 cfs is correct. Report will be revised.	**C**	ALN
5	4.6 Page 4-32	Option 4, indicates that "pumps rated at 1140 cfs would be required". The Sample Calculations. Indicate that this should be 1145 cfs.	**A** – 1145 cfs is correct. Report will be revised.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: June 29, 2000

Reviewer: Aaron Newman, P.E.

Telephone: (707) 763-7867

		Design Document				**Discipline**
	CENW____					
	Air Force		D. Memo		Concept	Architect
	Army	X	ITR P&S		Prelim.	Civil
X	Consultant		30%		Final	X Mech/~~Elec~~.
	Other	X	60%		BCOE	Structural
						Hydraulic

Action taken on Comments by:

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
6	4.7.3 Page 4-38	The recommendation to add a heater to the system is made. A pump system could be used to add heat to the system while at the same time it continually cleans the gear oil. The same thermostat that would be used on a heater could control the circulating pump. The efficiency of such a unit is poor but the improved oil quality will extend the life of the gearbox.	**A** – We believe an active heater is more positive. The existing lube oil pumping and cooling systems incorporate filters. We believe this is sufficient.	**C**	ALN
7	5.2.2.2 Page 5-5	The test that reduced the tailwater elevations from 636.7ft. to 633.2 ft, an increase in discharge head from 4 feet to 7.5 feet, caused the motors to overheat. The increase in load, even with the reduction of flow would be appreciable. It would be good to determine how much the load increased and the increase in the level of the diffuser system when the third pump is run.	**A** – It may be possible to determine when Pump 1 is tested in July or August.	**C**	ALN
8	5.4.3.1 Page 5-12	The same comment made in comment 6 applies.	**A** – See Item No. 6 response	**C**	ALN
9	5.4.3.2.b Page 5-14	Converting the controls to DC to eliminate a transformer does not assure a reliable source of power. It ensures a different set of problems including maintenance problems	**A** – Reliability not assured, but we believe improved. Most critical controls at plant are dc from station battery system.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 10, 2000

Reviewer: David Thomas, P.E.

Telephone: (415) 457-2739

		Design Document			**Discipline**
___ CENW___	___ D. Memo		___ Concept	___ Architect	
___ Air Force	X ITR	P&S	___ Prelim.	___ Civil	
___ Army	___ 30%		___ Final	X ~~Mech~~/**Elec.**	
x Consultant	X 60%		___ BCOE	___ Structural	
___ Other				Hydraulic	

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Action taken on Comments by: REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
1	Plate 2.1.1	Substation scheme shows separate ATS and pump switchgear line-up with withdraw type fuses and motor contactors. The other 5kV switchgear schemes for the Little Goose alternate 2 and 3 show combined ATS with the pump switchgear. I would assume the switchgear line-ups to be the same for all except for hp ratings.	**A** – This is correct. All schemes are physically similar, except for the horsepower ratings. Drawings will be revised.	**C**	DMT
2	Page 4-39: Wicket Gate Sticking	Considering the problems with both mechanical and electrical operation with the wicket gates, the conclusion reached may need rethinking. A hydraulic gate operator with dithering circuit may solve both mechanical and electrical problems.	**A** –This will be discussed further at 60% meeting. Alternate can be priced and evaluated if USACE believes warrented. (Note: USACE has opted for cycling gates on regular basis at 60% Review meeting – GBW)	**C**	DMT

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 5, 2000

Reviewer: Kelly B. Freeman

Telephone: (503) 624-3277

	Agency		Design Document				Discipline
	CENW____						
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.		Civil
X	Consultant		30%		Final		Mech/Elec.
	Other	X	60%		BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: R. Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
1	2.3.4	Engineer Manual 1110-2-3001 should also be listed for guidance and additional references for design of pipe under pressure, similar to penstocks, as occurs for Little Goose Alternative 1.	**A** – This will be used and added as a reference. In addition, EM 1110-2-3102 and EM 1110-2-3105 will be referenced (related to pump station design).	**C**	KBF
2	2.3.4	The latter part of the reference list has organizations publishing many documents. Reference to the Uniform Building Code (a single document) could be deleted since ICBO is previously listed.	**A** – True.	**C**	KBF
3	4.4.3.3.c	First Paragraph: The pipe is supported by a rigid structure at the face of the south non-overflow monolith and the fishwater pump discharge chamber, and on soil between. Solid bedding of the pipe and anchor blocks will be needed to reduce additional stresses from settlement or other movement of the more flexible soil. The design may also need to include some allowance for soil movements.	**A** – Harnessed flexible couplings will be added between the soil supported sections of pipe and those supported by the large concrete dam structures. It is assumed that the soil will be compacted to 95% of original density.	**C**	KBF
4	4.4.3.3.c	First Paragraph: The tailwater pool level will typically be above the bottom of the excavation(s) for the pipe and valve box. The level of the water table within the excavated area may be similar to the tailwater pool, requiring dewatering of the excavation during construction. The potential for this condition should be addressed.	**A** – This will be added to the report.	**C**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 5, 2000	**Reviewer:** Kelly B. Freeman	**Telephone:** (503) 624-3277	

Agency	Design Document		Discipline
____ CENW____	____ D. Memo	____ Concept	____ Architect
____ Air Force	X ITR P&S	____ Prelim.	____ Civil
____ Army	____ 30%	____ Final	____ Mech/Elec.
X Consultant	X 60%	____ BCOE	X Structural
____ Other			____ Hydraulic

Action taken on Comments by: R. Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
5	4.5.3.4.b	First Paragraph: Could the draft tube bulkheads be used in the draft tube bulkhead slots to allow dewatering for cutting into the fishwater conduit and installing the new bulkhead gates?	**A** – I doubt that the upper portions of the bulkhead slots were designed for sealing the slot. Also, I doubt the complexities of sealing the bottom of the slot and the modifications required to seal the bottom of the logs would be worth the effort. Relatively small dewatering coffer cells to fit around the openings would seem to be most appropriate. They might even be enlarged to include installation of the bulkhead gate guides in the dry instead of by divers. This will be noted in the text. The coffer cell could span the depth of the recess in the wall and to the bottom with a top closure. Seams that it would be pretty straight forward.	**C**	KBF
6	4.5.3.4.b	Third Paragraph: Forces due to motor or pump startup torque could cause transient resonance even if operating frequencies are dissimilar from structure frequencies. Although these pumps are intended to be used infrequently, design for connection durability and possibly fatigue may still be needed.	**A** –Yes.	**NA**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 5, 2000

Reviewer: Kelly B. Freeman

Telephone: (503) 624-3277

	Agency		Design Document				Discipline
	CENW____		**Design Document**				**Discipline**
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.		Civil
X	Consultant		30%		Final		Mech/Elec.
	Other	X	60%		BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: R. Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
7	4.5.3.4.b	Fourth Paragraph: Alignment and attachment of each pump station structure in a single piece may be more difficult than multiple operations. Alignment and attachment of a template mating structure (perhaps consisting of the pump chamber sidewalls) may be easier, with subsequent bolting on of larger components. The need to match the vertical dimensions of the existing structure may also make separation into componants desirable, with the pump chamber and lower pump housing installed first, and then the deck level motor and gearbox support platform.	**A** – True. The overall weight of the structure may also make this difficult to install as a single piece. This will be discussed in the report.	**C**	KBF
8	Plate 1.1.2	Where it leaves the south non-overflow downstream dam face, the 90" steel pipe could be turned down to vertical with a 90 degree bend and then sloped parallel to the dam toe with a 37 degree bend. This allows a simpler attachment to the dam face at two locations. The attachments can share the loads instead of concentrating them at the one at the base. Design, fabrication and installation of the supports, and maybe the pipe, should be easier.	**A** – I agree. We will review this and incorporate this change into the design if it checks out.	**C**	KBF
9	Plate 1.1.2	The valve pit is shown with the rim above the ground. Is this needed? There may be advantages to keeping it flush with the surrounding pavement.	**A** – Among other things, it eliminates the need to make it driveable (even with a curb around it, I would be afraid of it being driven on. We can also totally eliminate the grating and handrailing if the grating were eliminated.	**NA**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 5, 2000 | **Reviewer:** Kelly B. Freeman | **Telephone:** (503) 624-3277

	Organization		Design Document				Discipline
	CENW____						
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.		Civil
X	Consultant		30%		Final		Mech/Elec.
	Other	X	60%		BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: R. Wielick

Item No.	Dwg. Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
10	Plate 1.1.2	Means of access to the pipe interior for inspection and/or maintenance is not shown. Should it be provided?	**A** – Some provision for access should be made. It will be noted on the drawings that an access port will be included, located in the valve pit.	**C** – Noted in text but not shown in drawings.	KBF
11	Plate 1.1.2, 3	The flow chamber walls should use structural tee sections (WT) welded to the steel wall plates in place of the W sections shown.	**A** – We will review that.	**C**	KBF
12	Plate 1.1.3	Plan – El. 651.0: Will the platform bracing and interior framing at the deck level need to be removable to allow access for maintaintance or replacement of the sluice gates?	**A** – Yes. This will be noted in the report. All deck framing is assumed to be bolted so removal of discrete steel members should be possible if plans are made for it.	**C**	KBF
13	Plate 1.1.4	Section B: The "Longitudinal Support" may be better provided by a shear attachment to the thicker wall along the pipe. The "Longitudinal Support", or the penetration at the south wall, will also take the hydraulic thrust from the pipe end cap.	**A** – Probably. A horizontal brace back to the wall would work. In truth, the thrust will likely be taken by the 7' thick wall. Thrust retraints will be shown on the drawings at the pipe penetration (embedded thrust rings on the pipe).	**C**	KBF
14	Plate 1.2.1, 2	The pump chamber walls should use structural tee sections (WT) or welded tee sections, welded to the steel wall plates, in place of the W sections shown.	**A** – This will be reviewed.	**C**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 5, 2000

Reviewer: Kelly B. Freeman

Telephone: (503) 624-3277

	Agency		Design Document				Discipline
___	CENW____						
___	Air Force	___	D. Memo	___	Concept	___	Architect
___	Army	X	ITR P&S	___	Prelim.	___	Civil
X	Consultant	___	30%	___	Final	___	Mech/Elec.
___	Other	X	60%	___	BCOE	X	Structural
							Hydraulic

Action taken on Comments by: R. Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
15	Plate 1.2.1	Plan – El. 512.0: The outer rock anchors at the center pier look a bit close to the edge of the draft tube bulkhead slot. Two columns of bolts may be all that can be fit in.	**A** – We will review this configuration and consider this comment. Final detailing of the connection is left for final design.	**C**	KBF
16	Plate 1.2.2	In report section 4.5.3.3.a, first paragraph, the removal of the pump components for maintenance is described. Extraction of the lower pumping unit by cranes may be greatly facilitated if the floor framing, supporting the pump and gearbox at the deck level, were removable to allow a vertical lift.	**A** – That was the intent. The report text will be revised to describe this procedure. The deck framing is assumed to be bolted. Temporary removal of discrete beams should be assumed for removal of the pump.	**C**	KBF
17	Plate 1.2.2	In report section 4.5.3.4.b, first paragraph, installation of each pump structure as a single piece is described. Section A of Plate 1.2.2 should depict more specific structural continuity, between the deck level support and the lower structure, if the structure is to be transported and installed as a unit.	**A** – I think that your Comment No. 7 is valid. The text will be revised to indicate that construction installation would be accomplished with components bolted together at the site.	**C**	KBF
18	Plate 1.2.2	Section A: Attaching to the midspan of the crane rail beam may apply forces in excess of available capacity. A more substantial structure may be necessary to span across the entire opening without using the crane rail beam for support.	**A** – I agree. The crane beam may have reserve capacity, however, it would be prudent to span the 42' rather than attach to the beam. We will review this in the design.	**C**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 12, 2000

Reviewer: Marinus R. Voskuilen, P.E.

Telephone: (425) 452-8000

			Design Document				Discipline
	CENW____						
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.	X	Civil
X	Consultant		30%		Final	X	Mech/~~Elec~~.
	Other	X	60%		BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sheet Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
1	Page 4-14	Is the specific inclusion of the vendor name contrary to the Corps general philosophy of product/vendor neutrality? (This applies at other locations in the report as well.)	**A** – I believe it's a problem for Plans and Specifications but not for planning reports.	**NA**	MRV
2	Page 4-15, paragraph 3	How will the flow control valve be field calibrated?	**A** – Calibration could be accomplished by water level monitoring in the fishway and pump discharge chamber or use of a pitot rake through a port in the pipe to get velocities (and thus flow rates) in the pipe.	**NA**	MRV
3	Page 4-23, Item 4.5.3	Plates 1.2.3 and 1.2.4 were not included in the 60% report.	**A** – They will be later.	**C**	MRV
4	Page 4-31, First bullet	Is the second number supposed to be 2,550 or 2.550 cfs?	**A** – 2,550. This will be corrected.	**C**	MRV
5	Page 4-31 Item 4.6.3	Figure 1.3.3 was not included with the report.	**A** – It will be later.	**C**	MRV
6	Plate 1.1	The word "juvenile" is misspelled.	**A** – This will be corrected.	**C**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 12, 2000 | **Reviewer:** Marinus R. Voskuilen, P.E. | **Telephone:** (425) 452-8000

		Design Document				**Discipline**	
	CENW____						
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.	X	Civil
X	Consultant		30%		Final	X	Mech/~~Elec~~.
	Other	X	60%		BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sheet Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
7	Plate 1.1.2	Additional thrust restraints appear to be necessary by either depiction or callout.	**A** – This will be reviewed. The pipe coming out of the dam is being revised to a vertical 90-degree elbow followed by a vertical 37-degree elbow to follow the slope of the toe of the dam. This will provide additional support. A restraint at the 90-degree elbow may still be required. Restraints below grade will be called out. Text notes that they would be required.	**C**	MRV
8	Plate 1.1.2	Flow conditions immediately downstream of the butterfly valve in combination with a pair of bends is not likely to be uniform.	**A** – The diffuser is a high-loss element that is not sensitive to uniform flow conditions in the pipe. This should not be a problem.	**NA**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 12, 2000

Reviewer: Marinus R. Voskuilen, P.E.

Telephone: (425) 452-8000

		Design Document				**Discipline**	
	CENW____		D. Memo		Concept		Architect
	Air Force	X	ITR P&S		Prelim.	X	Civil
	Army		30%		Final	X	Mech/~~Elec~~.
X	Consultant	X	60%		BCOE	X	Structural
	Other						Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sheet Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
9	Plate 1.1.1	Will butterfly valve be able to regulate properly given the number of bends in the line both upstream and downstream of the valve?	**A** – For butterfly valves, optimum location is 5 pipe diameters downstream of an elbow. This can be reduced if the orientation of the valve is adjusted to reflect the plane of the upstream elbow. There are about 5 pipe diameters upstream of the valve. No restrictions on downsstream bends, etc. are known.	**NA**	MRV
10	Plate 1.1.2	Pipe ring stiffeners may be needed. This should be reviewed.	**A** – Pipe ring stiffeners would be required at the pipe support locations. These will be shown where supports are required.	**C**	MRV
11	Plate 1.1.2	Additional pipe support(s) may be needed in the more or less vertical section of 90-inch diameter pipe.	**A** – See response to comment No. 7	**NA**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: July 12, 2000	**Reviewer:** Marinus R. Voskuilen, P.E.	**Telephone:** (425) 452-8000			Page 4 of 4
___ CENW___ ___ Air Force ___ Army X Consultant ___ Other	**Design Document** ___ D. Memo ___ Concept X ITR P&S ___ Prelim. ___ 30% ___ Final X 60% ___ BCOE	**Discipline** ___ Architect X Civil X Mech/~~Elec.~~ X Structural Hydraulic	**REVIEW CONFERENCE** **A - Comment Accepted** **W - Comment Withdrawn** (If neither , explain)	**DESIGN OFFICE** **C - Correction Made** (If not, explain)	Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sheet Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
12	Plate 1.1.3	I am not clear about where the debris from the screen cleaner is being routed.	**A** – Per the text in Section 4.4.3.3., it would be put in a pipe and routed away from the immediate reservoir area (such as around the corner at the erection bay) and dumped back into the reservoir. This would be a gravity installation. It could penetrate the dam and be routed to the tailrace but that would be quite expensive.	**NA**	MRV
13	General	The Phase II report seems to address the issues related to the development of the EAWS in a reasonable manner.	**A** – Thanks!	**NA**	MRV
14	General	Some minor spelling errors were noted throughout the report.	**A** – Document was spellchecked. Any hints as to where these might be?	**C**	MRV
15	Page 4-14 Paragraph 2	Can specific site references to similar designs be provided and qualitatively be evaluated?	**A** – We will document at least one installation at the 100% Draft Report.	**C**	MRV
16	General	A three dimensional illustration of the existing flow routing would be helpful in visualizing the issues related to the location of supplemental flow introduction.	**A** – We will try to make the text more clear. Fortunately, the typical audience has a good understanding of the system.	**C**	MRV
17			**A** –		

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 11, 2000	**Reviewer:** Marinus R. Voskuilen, PE	**Telephone:** (425) 452-8000	

		Design Document			**Discipline**
___ CENW____	___ D. Memo		___ Concept	___ Architect
___ Air Force	X ITR	P&S	___ Prelim.	X Civil
___ Army	___ 30%		___ Final	X Mech/Elec.
X Consultant	X 100%		___ BCOE	___ Structural
___ Other				Hydraulic

REVIEW CONFERENCE: A - Comment Accepted; W - Comment Withdrawn (If neither , explain)

DESIGN OFFICE: C - Correction Made (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check
1	Cover	Use the JE Sverdrup logo instead of the Sverdrup logo.	**A** – Yes	**C**	MRV
2	ES-1	Fifth line - Capitalize the word "Lower" in the report title.	**A** – The text will be revised.	**C**	MRV
3	ES-2	In the first line under the heading EAWS Status, the abbreviation "FPP" has not been defined at this point.	**A** – The abbreviation will be defined here.	**C**	MRV
4	ES-2	In the same paragraph as comment 3, line 6, the expression "(EAWS)" does not seem to fit the context of the sentence.	**A** – The text will be clarified.	**C**	MRV
5	ES-3	Under the heading Alternative 3, the second sentence contains the phrase "where in which". I suggest deleting the word "where".	**A** – The text will be revised.	**C**	MRV
6	1-1	In Item 1.1, fifth line - Capitalize the word "Lower" in the report title.	**A** – The text will be revised.	**C**	MRV
7	2-4	Section 2.2.2, Third paragraph, Last sentence - Replace "was" with "were" two times.	**A** – The text will be revised.	**C**	MRV
8	2-9	Add the following abbreviations to the list: S&A - Supervision and Administration V - Vertical H - Horizontal msl - Mean Sea Level	**A** – The text will be revised.	**C**	MRV
9	2-9	Under the heading Section 2.4 add a note that the abbreviation list excludes codes and standards.	**A** – The text will be revised.	**C**	MRV
10	4-1	In Section 4.1, Fourth line - Two periods at the end of a sentence.	**A** – The text will be revised. The remainder of the document was also checked for double periods.	**C**	MRV
11	4-7	In the second paragraph from the bottom, eigth line - The date is not likely to have been "19915".	**A** – The text will be revised.	**C**	MRV
12	4-12	Second bullet, Last sentence - Use "their" instead of "there".	**A** – The text will be revised.	**C**	MRV

Review Comments
Project: Emergency Aux. Water Supply - Independent Technical Review
Location: Little Goose/Lower Granite Locks and Dams

Date: September 11, 2000
Reviewer: Marinus R. Voskuilen, PE
Telephone: (425) 452-8000

		Design Document				Discipline
___	CENW____	___	D. Memo	___	Concept	___ Architect
___	Air Force	X	ITR P&S	___	Prelim.	X Civil
___	Army	___	30%	___	Final	X Mech/Elec.
X	Consultant	X	100%	___	BCOE	___ Structural
___	Other					Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)
DESIGN OFFICE: **C - Correction Made** (If not, explain)
Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
13	4-20	Under Item c., fourth line - Suggest adding the word "exterior" as follows: Alternative interior and exterior coatings ..."	**A** – The text will be revised.	**C**	MRV
14	4-21	Paragraph b. Has consideration been given to the structural implications of a total plugging of the screen system as a result of a failure of the screen cleaner. Consideration might be given to some type structural safeguard that would allow unscreened flow in by way of a "weak link" panel.	**A** – It is probably more practical for this site to monitor water surface elevations differentials (forebay to interior of screen) since the project can respond directly to an alarm condition. This will be noted in the text.	**C**	MRV
15	4-22	First full paragraph. In the Corps' perspective, the use of metalized coatings is usually limited to high velocity areas or abrasive areas where a paint coating may not "stick". In other areas, they would be more likely to opt for a high quality paint coating.	**A** – This should be investigated more thoroughly during final design. The concern here is that the structure is not "removable" unless unbolted from the face of the dam. Thus, a durable, long-lasting coating system is required. If the COE high quality paint coating system is shown to have better performance characteristics, it should be used.	**NA**	MRV
16	4-22	Item C. Third sentence up from the bottom of the paragraph - Add the word "this". The sentence would read "...although this should be ..."	**A** – The text will be revised.	**C**	MRV

Review Comments
Project: Emergency Aux. Water Supply - Independent Technical Review
Location: Little Goose/Lower Granite Locks and Dams

Date: September 11, 2000 | **Reviewer:** Marinus R. Voskuilen, PE | **Telephone:** (425) 452-8000

		Design Document			**Discipline**
	CENW____		D. Memo		Architect
	Air Force	X	ITR P&S		Concept
	Army		30%		Prelim.
X	Consultant	X	100%		Final
	Other				BCOE

Discipline: ___ Architect; X Civil; X Mech/Elec.; ___ Structural; Hydraulic

Design Document: ___ Concept; ___ Prelim.; ___ Final; ___ BCOE

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
17	4-26	Third paragraph. The discussion about lost energy is valid only if the water would not be spilled anyway. (Total river flow<= power plan capacity.) I am not sure if this is completely valid for the entire duration.	**A** – True. This will be noted in the text.	**C**	MRV
18	4-27	First paragraph - See Item 17.	**A** – The text will be revised to note this here also.	**C**	MRV
19	4-29	Paragraph b. The effective screen area ratio of 0.9 seems a bit high. Has this been confirmed.	**A** – Not specifically. This is an estimate. If the amount of support steel is greater (lower ratio), the screen panels would need to extend higher.	**NA**	MRV
20	4-36	Third paragraph - See coating comments in Item 15.	**A** – The caveat in the previous section applies here also.	**C**	MRV
21	4-40	Last paragraph - See Item 17.	**A** – The text will be revised to include a statement about this.	**C**	MRV
22	4-51	First full paragraph - First line - Change "is" to "are".	**A** – "is" was changed to "include"	**C**	MRV
23	4-52	First paragraph - The comments water and energy loss are valid only if water would not be spilled anyway. See Item 17.	**A** – This will be noted in the text.	**C**	MRV
24	4-54	The table provided on this page has no heading and does not seem to have a logical tie to the text.	**A** – A title will be added to the table. The tie to the text is in the preceeding paragraphs.	**C**	MRV
25	4-58	Under paragraph c, the listed TDH values are the same. Is this correct?	**A** – No. The TDH for the larger pumps should be 6.7 feet. This will be corrected.	**C**	MRV
26	4-58	Item d, Line 3, delete the word "with".	**A** – The text will be revised.	**C**	MRV
27	5-6	Third full paragraph, Line 4 - Replace "where" with "were".	**A** – The text will be revised.	**C**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 11, 2000	**Reviewer:** Marinus R. Voskuilen, PE	**Telephone:** (425) 452-8000	

Agency	Design Document		Discipline
___ CENW____			
___ Air Force	___ D. Memo	___ Concept	___ Architect
___ Army	X ITR P&S	___ Prelim.	X Civil
X Consultant	___ 30%	___ Final	X Mech/Elec.
___ Other	X 100%	___ BCOE	___ Structural
			Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check
28	5-14	The table provided on this page has no heading and does not seem to have a logical tie to the text.	**A** – A table heading will be included.	**C**	MRV
29	5-15	First partial paragraph on the page - Last sentence - Delete extra period.	**A** – The text will be revised.	**C**	MRV
30	Plate 1.1.2	Access into the pipe is discussed in the text, but not depicted on the drawing.	**A** – Yes.	**NA** – Desribed in text but not shown on drawings	MRV
31	Plate 1.1.3	Has clearance with makeup water intake trash rack been verified?	**A** – No. As we understand it, there is no raking device that is employed for this rack.	**NA**	MRV
32	Little Goose Cost Estimates	The unit costs shown for plate steel (0.53) seem low.	**A** – Per the calculations (CE-01-0502) number includes a 50% increase for fabrication over the raw steel costs. An adjustment of painting should be included and will be included in a revised estimate. The cost for this item will be reviewed.	**C**	MRV
33.	Little Goose Cost Estimates	The unit costs for platform steel (1.50) seem low.	**A** – Per the calculations (CE-01-0502) number includes a 50% increase for fabrication over the raw steel costs. An adjustment of painting should be included and will be included in a revised estimate. The cost for this item will be reviewed.	**C**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 11, 2000 | **Reviewer:** Marinus R. Voskuilen, PE | **Telephone:** (425) 452-8000

		Design Document				**Discipline**
	CENW____					
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.	X	Civil
X	Consultant		30%		Final	X	Mech/Elec.
	Other	X	100%		BCOE		Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted** / **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
34	Little Goose Cost Estimates	The unit costs for 90" steel water supply (780) seem low.	**A** – This cost is per the pipe manufacturer. Comparing to Means cost for 96" pipe, which is about $630 for pipe installed, this compares pretty favorably.	**NA**	MRV
35	Little Goose Cost Estimates	The unit costs for restoring AC paving (0.42) seem low.	**A** – It is. The calculation checking identified this to be an error. The revised cost will be $1.36 per SF.	**C**	MRV
36	Lower Granite Cost Estimates	The cost estimates are shown as being unchecked.	**A** – These will be checked.	**C**	MRV
37	References	The last reference needs to be completed.	**A** – Yes.	**C**	MRV

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** Aaron Newman, P.E. | **Telephone:** (707) 763-7867

	Agency		Design Document					Discipline
____	CENW____							
____	Air Force	____	D. Memo		____	Concept	____	Architect
____	Army	X	ITR	P&S	____	Prelim.	____	Civil
X	Consultant	____	30%		____	Final	X	Mech/~~Elec~~.
____	Other	X	100%		____	BCOE	____	Structural
								Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Gerald Walker and Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
1	P. 4.8.2.3	Submersible pumps by their design are not maintainable. They cannot be inspected easily and removal for repair is a major undertaking. A "hostile" environment surrounds the electrical motor and gearbox and leakage is catastrophic. Does the price of the pump include moisture sensing in the motor and/or gearbox?	**A** –Moisture and oil level sensors are available. They are not included in estimate. The estimated additional cost is $2000 per pump for sensors and circuitry. This will be included in the estimate and in the text..	**C**	ALN
2	P. 4.8.3	The maintenance discussion indicates that "The Corps is familiar with and accustomed to large pumping stations" and there fore these pumps are no different. Large submersible pumps of this type are different. What is the MTBF for similar pumps in similar service? Has this technology been proven for life expectancies similar to this project?	**A** – We are in process of receiving comments from plant maintenance staff to determine their experiences and concerns.	**C**	ALN
3	P. 4.8.4	For a line shaft pump the structure may be more complicated but otherwise the pump arrangement would be similar. Have line shaft pumps been considered for this application?	**A** – The development of this design with line shaft pumps was considered but resulted in a more complex structure and greater cost. The adaptation of the structure for line-shaft pumps is being reviewed for the final report and may appear as an appendix to show how it might look. Certainly, if the COE has a preference for line shaft pump designs, these would be adopted for the final design.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000	**Reviewer:** Aaron Newman, P.E.	**Telephone:** (707) 763-7867			Page 2 of 6
___ CENW___	**Design Document**	**Discipline**	**REVIEW CONFERENCE**	**DESIGN OFFICE**	Back Check By:
___ Air Force	___ D. Memo ___ Concept	___ Architect			
___ Army	X ITR P&S ___ Prelim.	___ Civil	**A - Comment Accepted**	**C - Correction Made**	
X Consultant	___ 30% ___ Final	X Mech/~~Elec~~.	**W - Comment Withdrawn**		
___ Other	X 100% ___ BCOE	___ Structural	(If neither, explain)	(If not, explain)	(Initials)
		Hydraulic			

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Action taken on Comments by: Gerald Walker and Rolf Wielick		
4	P. 4.9	Operation and Maintenance: The System reliability, System maintainability for Alternative No. 5 needs to be reviewed. What is the basis for determining that it is Excellent?	**A** – Good comment. Maintenance requirements for the pumps would be comparable to Alternative 2 except that from a system approach, the presence of the fish screens gives a clear advantage to Alternative 5. Alternative 5 has less components to maintain but the pump is less accessible and more difficult to disassemble once removed. Maintainability will be downgraded from "Excellent" to "Good" and Alternative 2 will be adjusted accordingly.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** Aaron Newman, P.E. | **Telephone:** (707) 763-7867

___ CENW____	**Design Document**		**Discipline**		
___ Air Force	___ D. Memo	___ Concept	___ Architect		
___ Army	X ITR P&S	___ Prelim.	___ Civil		
X Consultant	___ 30%	___ Final	X Mech/~~Elec~~.		
___ Other	X 100%	___ BCOE	___ Structural		
			___ Hydraulic		

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE **A - Comment Accepted** **W - Comment Withdrawn** (If neither, explain)	DESIGN OFFICE **C - Correction Made** (If not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Gerald Walker and Rolf Wielick		
5	P. 4.9	Maintenance Costs for Alternative No.5 are only excellent if there is no need for maintenance. The removal of these pumps is no trivial project. Has a cost analysis been done on the cost of removal and the expected removal interval?	**A** – MWI submersible pumps are installed in an encasing pipe. Pump radial alignment is maintained by guides and mating grooves. Vertical positioning by pump weight and hydraulic thrust. Pump removal would be a straight lift by a mobile crane using a permanently attached cable. Installation requires aligning guides and grooves and lowering pump. A diver may be required for guidance during initial insertion of the pump into the pipe. This will depend on how high the pipe extends and will be a tradeoff during final design. Once removed, maintenance is straightforward in the plant's shop. The text will be expanded to describe basic maintenance requirements.	Maintenance of a sealed pump is <u>not</u> a straight forward precess given the seals and sealing problems. This should be investigated further with plant maintenance. -ALN	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** Aaron Newman, P.E. | **Telephone:** (707) 763-7867

		Design Document				**Discipline**
	CENW____					
	Air Force		D. Memo		Concept	Architect
	Army	X	ITR P&S		Prelim.	Civil
X	Consultant		30%		Final	X Mech/~~Elec~~.
	Other	X	100%		BCOE	Structural
						Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Gerald Walker and Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
6	P. 4.8.4	Other Issues: No mention is made that there is a large reservoir of oil stored in each gearbox and possibly each motor. Are there any concerns that this oil might leak?	**A** – The MWI pumps used for this design uses an environmentally acceptable vegetable based oil. We are in the process of obtaining a list of similar pump installations. Oil level sensor is available and will be included in the report..	Bio-degradable oil is not compatible with water. It is doubtful that water can be excluded over long term. - ALN	ALN
7	P. 4.8.4	Other Issues: No mention is made that there is a large reservoir of oil stored in each gearbox and possibly each motor. Is there a requirement for secondary containment for this equipment?	**A** – See Comment 6 response	See my Comment 6 response - ALN	ALN
8	P 4.9.2	The recommendation of Alternative 5 is based on a cost analysis that has not heretofore not been reviewed. There are similarities between the pumps in Alternative 2 and Alternative but the difference in cost is appreciable. Is there that much difference in the manufacture of these pumps to justify this difference in cost?	**A** – The cost analysis has been checked as indicated by the initials in the "Checked By" box on the cost estimate. The equipment cost information comes from MWI-Couch and is assumed to be correct.	Still have doubts on relative pricing but OK. - ALN	ALN
9	Estimate of Cost for Alternative 3	The Turbine is smaller in size than the gearbox and is on the same level as the gearbox, and is more accessible than the pump. Therefore the cost of removal should be less than either. Would a cost of removal in the $12,000 range be more in line?	**A** – The turbine requires disassembly of the runner and shaft and various auxiliaries (gateshaft operator system, pipe connections) as well as movement to be under the hoisting point. The gearbox is already under the hoist point and is fairly self contained.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** Aaron Newman, P.E. | **Telephone:** (707) 763-7867

		Design Document				**Discipline**
___	CENW____	___	D. Memo	___	Concept	___ Architect
___	Air Force	X	ITR P&S	___	Prelim.	___ Civil
___	Army	___	30%	___	Final	X Mech/~~Elec~~.
X	Consultant	X	100%	___	BCOE	___ Structural
___	Other					___ Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Gerald Walker and Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check
10	Estimate of Cost for Alternative 2	Pump Equipment is listed including many auxiliaries. Is it possible to separate the pump/motor/gearbox cost from the associated equipment?	**A** – MWI quotation was all inclusive. Separate prices for components were not obtained.	**C**	ALN
11	Estimate of Cost for Alternative 4	Should 480 Main Circuit Breaker Units be EA not LF?	**A** –Yes. Estimate will be changed	**C**	ALN
12	Estimate of Cost for Alternative 5	Should 5000V Main Station Circuit Breaker Units be EA not LF?	**A** – Yes. Estimate will be changed	**C**	ALN
13	Estimate of Cost for Alternative 5	The Excavation and Backfill numbers do not seem to be enough to include hauling and off site storage. Was this included?	**A** – The estimate assumes a 300' haul. This is about as refined as can be expected at this level of development.	**C**	ALN
14	Estimate of Cost for Alternative 5	There is no specific area noted for monitoring the moisture in the pumps. Is this included in the cost of the pump? If so how much is it?	**A** – Monitoring will be added to costs and text	**C**	ALN
15	Estimate of Cost for Alternative 5	The 92,000 GPM pump is similar to the 100,000 GPM pump in Alternative 2. Why is there such a difference in price?	**A** – The pumps for Alternative 2 are considerably larger in terms of the overall size (not pumping capacity, but physical size) and complexity of fit-up. These costs came from the same person at the same company, so the consistency in the approach in the pricing would be good.	See my comment 8 response - ALN	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000

Reviewer: Aaron Newman, P.E.

Telephone: (707) 763-7867

			Design Document				**Discipline**
	CENW____						
	Air Force		D. Memo		Concept		Architect
	Army	X	ITR P&S		Prelim.		Civil
X	Consultant		30%		Final	X	Mech/~~Elec~~.
	Other	X	100%		BCOE		Structural
							Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither, explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Gerald Walker and Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
16	Estimate of Cost for Alternative 5	The 150,000 GPM pump is one and a half times the size of the 100,000 GPM pump in Alternative 2 and the Alternative 5 pump does not include any of auxiliary equipment listed. Why is there such a difference in price?	**A** – See response for Item 15.	See my comment 8 response - ALN	ALN
17	Estimate of Cost for Alternative 5	The Pump Support Structure seems to be under valued. Would a value of $100,000 be more in line?	**A** – It is envisioned that the support structure would consist of steel shapes in a welded configuration bolted to the concrete slab. The $20,000 cost would allow for about 10,000 lbs of steel which should be more than enough for the pump supports.	**C**	ALN

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** David Thomas, P.E. | **Telephone:** (415) 457-2739 | Page 1 of 1

			Design Document				Discipline
	CENW____		D. Memo		Concept		Architect
	Air Force	X	ITR P&S		Prelim.		Civil
	Army		30%		Final	X	~~Mech~~/Elec.
x	Consultant	X	100%		BCOE		Structural
	Other						Hydraulic

Action taken on Comments by: David Absher and Gerald Walker

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither, explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
1	Para 5.4.5	Design and Construction Issuses: Delete second "speed reducer heaters" (duplicate).	**A** - Text will be revised	**C**	DMT
2	Plate 1.2.3	(N) 51 device should be (N) 50/51 (2 places) (N) 51N device should be (N)50/51N (2 places)	A – Plate will be revised	**C**	DMT
3	Plate 1.3.3	Same as Comment 2	**A** – Plate will be revised	**C**	DMT
4	Cost Estimate LGO Alt 3, pg 2	2500 KVA Station Service Transformer price is too high. Unit price of $150,000 would be more appropriate. ($385,450 now)	**A** – Estimate will be revised	**C**	DMT
5	Cost Estimate LGO Alt 4, pg 1	Automatic Transfer Switch For Pump 1 price is too high. Unit price of $8,000 would be more appropriate ($34,600 now). Also identify as "480 V".	**A** – Estimate will be revised	**C**	DMT
6	Cost Estimate LGR Alt 1, pg 1	Automatic Transfer Switch price is too high. Unit price of $40,000 would be more appropriate ($122,500 now).	**A** – Estimate will be revised	**C**	DMT
7	DDR App. A-4	Revise "Typical Costs" sheets per the above.	**A** – Cost sheets will be revised.	**C**	DMT

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000

Reviewer: Kelly B. Freeman

Telephone: (503) 624-3277

	Agency	Design Document			Discipline
___	CENW____	___ D. Memo		___ Concept	___ Architect
___	Air Force	X ITR	P&S	___ Prelim.	___ Civil
___	Army	___ 30%		___ Final	___ Mech/Elec.
X	Consultant	X 100%		___ BCOE	X Structural
___	Other				___ Hydraulic

REVIEW CONFERENCE: **A - Comment Accepted**, **W - Comment Withdrawn** (If neither , explain)

DESIGN OFFICE: **C - Correction Made** (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	**COMMENTS**	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
1	4.4.2.4.c paragraph 1	If diamond wire sawing is used to make a hole through the non-overflow section, a coffer dam will be needed on the forebay face prior to the drilling of smaller initial holes, through which the wire saw loop will be passed. The text indicates a coffer dam is needed only for a final operation.	**A** – The text will be modified to delete the word "final".	**C**	KBF
2	4.5.2.4.c	Will the time required to pump water out of the chambers, for concrete removal and other activities, be significant relative to the January 1st to March 1st window, and overall construction schedule? How about for other alternatives?	**A** – These water passages are dewatered through the use of dewatering pumps specifically designed for this purpose. This should not be an issue.	**NA**	KBF
3	4.8.2.4.b paragraph 3	Unless the construction savings are significant, it may be prudent not to assume there will be a reduction in net pressure on the wall due to flooding of the chambers prior to backfilling. The water surface will normally be close to the tailwater level if, for example, the pool is drawn down in anticipation of a major flood event, and the depth of the water inside the chamber will not be that great. The walls will then be subject mostly to the soil pressure loading, although the groundwater pore pressure will likely be reduced as well. Designing to require prior flooding also creates a restriction on the sequence of construction operations by requiring delay of the backfilling until after the chambers are flooded.	**A** – You might be right. This refinement in design should be investigated during final design to establish which approach is most advantageous.	**NA**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 1, 2000 | **Reviewer:** Kelly B. Freeman | **Telephone:** (503) 624-3277

	Organization		Design Document				Discipline
____	CENW____						
____	Air Force	____	D. Memo	____	Concept	____	Architect
____	Army	X	ITR P&S	____	Prelim.	____	Civil
X	Consultant	____	30%	____	Final	____	Mech/Elec.
____	Other	X	100%	____	BCOE	X	Structural
							Hydraulic

REVIEW CONFERENCE: A - Comment Accepted; W - Comment Withdrawn (If neither, explain)

DESIGN OFFICE: C - Correction Made (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	Review Conference	Design Office	Back Check By
4	4.8.2.4.b paragraph 5, 6	To maintain the stability of an open-cut excavation below the groundwater level probably would require dewatering by wellpoints around the perimeter of the excavation. The well pump system must be continuously operated until the excavation is backfilled to prevent failure of the excavation slopes. This and other complications may make the vertical shoring option the more likely method of excavation.	**A** – A geotechnical evaluation of the excavation might be warranted during final design to confirm the most appropriate strategy.	**NA**	KBF
5	4.8.2.4.c paragraph 6	The six rectangular openings in the west wall of the existing structure and, possibly, the three 96-inch holes in the intake roof could be made prior to completion of the roof of the new pump chambers. This maybe could be more easily accomplished without the restriction of working through the access hatches.	**A** – Yes. Although the 10'x10' openings should provide good access.	**NA**	KBF
6	Plate 1.1.2	The concrete valve pit will need to be designed for groundwater uplift pressures and buoyancy. To resist buoyancy the footing may need to be extended beyond the outside face of the walls to key it into the surrounding soil.	**A** – This will be noted in the text. It is dependent on the actual groundwater elevation which has not been established. This is true also for the pipe, of course.	**C**	KBF
7	Plate 1.5.2 Section A & B	The savings in concrete material by tapering west wall of the new chambers will probably not offset the additional cost of construction over making the wall a uniform thickness. A uniform thickness will make forming, placing reinforcing and placing concrete easier. The thicker wall at the top also may allow spanning between the separating and side walls without the roof and allow the roof construction to follow backfilling the excavation. Flexibility in the construction sequencing may shorten the overall schedule and reduce costs.	**A** – With this thickness of wall, the volume of concrete saved is considerable. A similar design was employed on the existing wall adjacent to this structure. Options for this wall would be investigated more thoroughly in final design.	**NA**	KBF

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 10, 2000 | **Reviewer:** Mizan Rashid | **Telephone:** (425) 881-7700

	CENW____		**Design Document**		**Discipline**		
____	Air Force	____	D. Memo	____ Concept	____ Architect		
____	Army	X	ITR P&S	____ Prelim.	____ Civil		
X	Consultant	____	30%	____ Final	____ Mech/Elec.		
____	Other	X	100%	____ BCOE	____ Structural		
					X Hydraulic		

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Perry Johnson		
1	General Comment	The discussions of the hydraulic/fisheries issues and the supporting hydraulic analyses presented in this report are very thorough. The authors have adequately addressed most of the issues/comments from the 60% submittal.	**A** – Thank you	**NA**	MR
2	General comment	As indicated in the ITR comment for the 60% submittal, quality of water from different sources such as forebay and tailrace could be an issue. Even though, for an emergency water supply system that is expected to be operational only for a short duration, this may not be a big concern. For the sake of completeness of the analyses, it would be prudent to include a short discussion about water quality in the text.	**A** – While considering this ITR comment for the 60% review, we noted that currently attraction water is taken from the tailrace immediately below the traft tube outlets. Consequently, water taken from a deep level withdrawal (the turbine intakes) is used for attraction. This is a worst case with respect to matching water quality. As a consequence, it was decided not to include a discussion on water quality, to not open that door, in the report.	**C** – A comment was included in the report text to address this issue.	MR

Review Comments

Project: Emergency Aux. Water Supply - Independent Technical Review

Location: Little Goose/Lower Granite Locks and Dams

Date: September 10, 2000 **Reviewer:** Mizan Rashid **Telephone:** (425) 881-7700

		Design Document		**Discipline**
___ CENW____	___ D. Memo		___ Concept	___ Architect
___ Air Force	X ITR	P&S	___ Prelim.	___ Civil
___ Army	___ 30%		___ Final	___ Mech/Elec.
X Consultant	X 100%		___ BCOE	___ Structural
___ Other				X Hydraulic

Action taken on Comments by: Perry Johnson

Item No.	Dwg, Sht./Page/ Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - Comment Accepted W - Comment Withdrawn (If neither , explain)	DESIGN OFFICE C - Correction Made (If not, explain)	Back Check By: (Initials)
3	Sec. 4.4.2.1 Page 4-15	An operating guideline should be developed so that plant personnel can follow the guidelines during emergency operations. For example, page 4-15, first bullet – "the sluice gates at the forebay intake are opened to allow full hydrostatic head to be applied to the closed sleeve valve in the supply line." The operating guideline should indicate how slow or quick the gate should be opened to achieve the full hydrostatic head near the closed sleeve valve. The operating guideline should include the steps and procedures for filling and draining the 90-inch supply pipe.	**A** – Agree. Operating guidelines should be developed in conjunction with development of a final design.	**NA**	MR
4	Little Goose, Alternative 1	Since the fish screen, baffles, sluice gate and the flow control valve will be used only during emergency situations, the operating guideline should include scheduled operation of the emergency water supply system to ensure that all the components are in working order when emergency situations occur.	**A** – Agree. Note that it is quite possible that the EAWS developed could be incorporated into routine system operation.	**NA**	MR
5	Plate 1.1.2	Installation of two combination air/vacuum valves appears to be sufficient for the length of the supply pipe. However, a waterhammer analysis should be done (if this option is pursued beyond the Phase II level) to verify system pressures during critical operating scenarios, such as closing or opening the flow control valve (72-inch sleeve valve) and the sluice gate.	**A** – Agree	**NA**	MR

APPENDIX B

Technical Review Comments

and

Meeting Minutes

Sverdrup Civil, Inc. Northwestern Region/Seattle

March 8, 2000
X310 01 MM 001

MEETING MINUTES

DATE:	February 28 and 29, 2000
TIME:	10:00 AM – 3:00 PM (February 28) , 9:00 AM – 3:00 PM (February 29)
PLACE:	Little Goose Dam (Feb. 28), Lower Granite Dam (Feb. 29)
SUBJECT:	USACE Walla Walla District - Contract No. DACW68-99-D-0003 Task Order No. 1 – Little Goose / Lower Granite Emergency Auxiliary Water System (EAWS) Site Visit – Project Kickoff Meetings

February 28, 2000 – Little Goose Dam:

ATTENDEES:

Name	Company	Phone Number	Location
Ron Porter	USACE - Walla Walla	(509) 527-7519	Walla Walla, WA
Van DeWitt	USACE - Walla Walla	(509) 527-7562	Walla Walla, WA
Ray Eakin	USACE – Little Goose	(509) 399-2233	Little Goose Dam
David Embree	USACE – Lower Granite	(509) 843-1493	Lower Granite Dam
Rolf Wielick	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA
Steve Wittmann-Todd	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA
Perry Johnson	ENSR	(303) 697-1989	Morrison, CO
Dave Absher	DCV Consultants	(206) 669-4833	Seattle, WA
Jerry Walker	DCV Consultants	(415) 457-2739	San Rafael, CA

MINUTES:

These meetings, the Initial Meetings for Task Order No. 1, are required meetings per the statements of work for the Task Order and were scheduled to be conducted at the project sites, Little Goose and Lower Granite Dams. The visit to Little Goose Dam occurred on February 28, while the visit to Lower Granite Dam occurred on February 29. The meetings allow for items of concern and the scopes of work to be discussed as well as an opportunity to visit the project site areas. These minutes represent our interpretation of the discussions of the meetings and serve as our record of those discussions.

1. We arrived at Little Goose Dam at about 9:00 am and proceeded to the lunch room area where we met Ray and David. We began with a general discussion about the project and what we wanted to accomplish. Basically, the Sverdrup team was interested in reviewing the auxiliary water system (AWS) at the dam in the context of the Phase I report that was prepared in 1995 by Raytheon. We wanted to look at the various facilities at the dam that were described in the report, look at where proposed facilities in the report were located, confirm the findings in the report in terms of the operations of the fishway, engage in discussions with plant operators to gain their perspective of the system and its shortcomings, if any. To do this, we will need to talk to plant operations staff, tour the dam, see the equipment, and review plant documents related to operations and maintenance, as well as project drawings that we might find useful for the project.
2. Ray began with an overall description of the AWS. He noted that in general, the AWS is in conformance with the latest Fish Passage Plan (FPP) which apparently has been updated over the 1995 Plan cited in the Phase I report. Exceptions include an inability to provide an 8.0-ft flow depth at the entrances when operating with low tailwater and slightly inadequate discharges generated at the north fishway entrance (differentials of approximately 0.8-ft instead of the desired 1.0 to 2.0 ft). Ray noted that the agencies were aware of these problems and had accepted this situation. Rolf asked if Sverdrup could get a copy of the updated FPP. He said that he would put a list together of items that Sverdrup needed and would forward the list to Ron.
3. Ray noted that they currently operate all three pump-turbine machines simultaneously to supply water to the AWS. This is conflict with the Phase I report which suggests that the AWS needs can be met with 2 pumps operating. Ray said that regardless of that, they operate all three at the same time (pumped flow and combined turbine discharge of approximately 260 cfs contribute to the AWS flow). They also draw water from the juvenile fish bypass system (about 240 cfs). He showed us a diagram out of the operations manual for the fishway that showed how the system works. Rolf requested a copy of the fishway operations manual which Ray gave him. Rolf will have it copied and returned to the project by the end of the week. Ray said that there were a few "problem" areas in the AWS and fishway that had been reviewed in the past. One was the discharge problems at the north shore fishway (noted above), and the other was a slack water reach around the channel bifurcation which did not meet the required minimum channel velocities of 1.5 fps (the range is 1.5 to 4 fps). A number of people have looked at these issues over the years. Lynn Reese (COE Walla Walla) has been involved in some of that work. Perry asked if we could get a copy of the hydraulic study. Ron said that Lynn should be able to find that and provide it. Rolf will include that on his list.
4. Ray said that because of the flow problems in various parts of the system, many of the control gates had been taken out to reduce headloss to the very minimum. He also noted that several of the floating orifice entrances on the powerhouse attraction channel had been bulkheaded. The two weir orifices at the north end of the powerhouse are open. He said that there was speculation that one of the reasons that there is a flow problem to the north shore fish ladder is a rather inefficient hydraulic condition occurring on the north end of the

powerhouse supplying the floor diffuser there caused by the water conduit taking a series of dramatic 90-degree bends.

5. The fish pumps are operated so that they are pumping against about 4 feet of head (this likely varies with changes in tailwater elevation and discharge) in the pump chamber. Ray noted that there is a belief that the pumps operate at less capacity then they are rated.
6. Rolf asked about the spiral case tap that appears in the Phase I report. Ray was not familiar with that concept and couldn't comment on how the project felt about it.
7. We then departed for a tour of the project. The first stop was the control room where we observed the plant operators working on new software that had been recently installed to monitor plant conditions and operations. The fishway screen shows water surface elevations at various locations in the fishway. Ray showed us the fishway status drawing which depicts the status of the various components of the fishway. From there we went to the pump/turbine room. We observed three Francis turbines driven by a single penstock from the forebay. Each turbine was coupled with one propeller pump located about 70 feet below. Power was transferred to the pump through a large gear box. All three systems were running. Ray explained that there was a spare gear box located in the generator hall that can be installed with relatively short notice. This spare gear box is shared with Lower Monumental which has a similar system. We spent a considerable amount of time looking at the machinery. Jerry took the "pulse" of the various components in an attempt to assess the relative condition of the equipment and noted a "knock" in Pump 1 at frequency of rotating speed. A more detailed analysis would require review of the maintenance records, etc.
8. After the pump room, we walked out onto the tailrace deck of the powerhouse and walked north to the central non-overflow section. Besides confirming that the AWS was operating, there was relatively little to see here.
9. We then went to the top of the dam and looked at the various locations proposed for the gravity intake for the AWS from the Phase I report. It was not clear how a large screening facility could be adapted to the south end of the powerhouse for the intake. This will have to be reviewed in more detail. We then went to the north shore and looked at the proposed gravity intake location there.
10. After our tour, we went back to the lunch room and had lunch. After lunch we spent the rest of the afternoon going over project drawings and other project documents to determine what we needed for the project.
11. (See attached trip notes from DCV Consultants for more detail on the pumping equipment at Little Goose).
12. We departed Little Goose at about 3:30 pm for Walla Walla.

February 29, 2000 – Lower Granite Dam:

ATTENDEES:

Name	Company	Phone Number	Location
Ron Porter	USACE - Walla Walla	(509) 527-7519	Walla Walla, WA
Kevin Renshaw	USACE - Walla Walla	(509) 527-7570	Walla Walla, WA
Dick Hammer*	USACE – Lower Granite	(509) 843-1493	Lower Granite Dam
David Embree	USACE – Lower Granite	(509) 843-1493	Lower Granite Dam
Jim Holston*	USACE – Lower Granite	(509) 843-1493	Lower Granite Dam
Coleyne Lasher*	USACE – Lower Granite	(509) 843-1493	Lower Granite Dam
Rolf Wielick	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA
Steve Wittmann-Todd	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA
Perry Johnson	ENSR	(303) 697-1989	Morrison, CO
Dave Absher	DCV Consultants	(206) 669-4833	Seattle, WA
Jerry Walker	DCV Consultants	(415) 457-2739	San Rafael, CA

* Participated on a part-time basis during the site visit.

13. We arrived at Lower Granite at about 10:00 am. Upon our arrival, there was a crew of people completing some modifications to the fish ladder. These will create higher walls on the lower ladder to force more water through the orifices. The ladder was dry and was going to be watered up during the day to get ready for March 1 start of operations. We went up to the offices and met Dick Hammer. We explained what we were doing at the project and what we hoped to accomplish. Dick noted that he would probably have one of his staff explain the AWS system in detail for us but he could provide a more general overview of the system.
14. The Lower Granite AWS operates with the use of two pumps with a third pump not operated (FP #1). The pumps are motor-driven unlike Little Goose which are turbine-driven. They have about the same capacity as the Little Goose pumps. Only two are required to meet the FPP criteria. Dick noted that the north shore fish ladder discharge is occasionally less than desired (differentials of 0.8 to 0.9–ft) but that the agencies have accepted this. Again, this is tailwater related.
15. Rolf asked why they didn't use the third pump. Apparently this pump has not been operated for a long time. It had not been used since Dick had been there (1995). From the discussion, it appeared that it had not been used for as long as anyone could remember. A bulkhead gate had been deployed over the discharge to keep it from back spinning and loosing water back to the tailrace. Jim Holston, who is mechanical maintenance supervisor at the project, noted that he thought that the problem was that the gear box was defective. It was thought that the pump had run until about the early 1980's but then had mechanical problems after which they could not get the manufacturer to warranty the equipment. It had not been used (as an integral part of the AWS system) since. It was not considered to be a functional piece of equipment by the plant staff. This is somewhat in contrast to the

conclusions of the Phase I report which does not report any operational problems with the pump as of 1995. That report concludes that spare capacity is available due to the presence of the three pumps available and only two operating at one time. Jim noted that there is a spare gear box at Lower Granite for the AWS pumps. It was not clear why that gear box had not been installed if there were concerns about the adequacy of the gear box on FP#1.

16. Rolf asked about the power supply to the pumps. The Phase I report notes that reliability of the system could be dramatically improved if a second motor controller were added with two motor starters and the power feeds to the pumps were reconfigured to increase redundancy. It was suggested that Coleyne could join us on the tour to try to explain the electrical issues at the pumps.
17. We then went down to the control room and after that, to the pump room. This installation is similar to that at Little Goose except that there are large motors instead of Francis turbines to drive the pumps. The equipment was not operating at the time since the fishway was not in service. The pump systems are in separate soundproof enclosures that also serve to keep the temperatures moderated around the motors. We looked at the equipment for a consider amount of time. Since the equipment wasn't operating, it was difficult to "take its pulse" like we had at Little Goose. David looked at the electrical equipment and from his discussions with Coleyne, was not able to confirm the conclusions from the Phase I report. There appears to be some disagreement on the whole electrical configuration. (Later when we were in the powerhouse offices, the CADD drawing was reviewed and it appeared to disagree with what was believed to be the actual field conditions.) This will have to be reconciled as will the actual status of FP#1. It was suggested that a couple of the "old timers" who had retired could be queried about the pumps.
18. We then walked outside and looked at the rest of the site. It is very much like Little Goose in configuration. The odd supply conduit configuration at the north end of the powerhouse also appear at Lower Granite. Again, this may be one of the features adding additional headloss to the system. On the deck of the dam, we looked at the proposed location of the gravity feed intake described in the Phase I report. Steve looked at the location of the removable spillway weir (RSW) that is being developed under Sverdrup T.O. No. 3.
19. After our site visit, we went to the engineering offices. There we proceeded to go through the project drawings, project documentation, and O&M manuals. Rolf asked if we could get a copy of the fishway operations manual. A copy was provided to him. Jerry went through the pump manuals. Jim Halston provided the team with a copy of the maintenance logs for the equipment related to the fishway.
20. Rolf asked Kevin if he had any knowledge of why the scroll case taps were not pursued further in the Phase II report for the Western Projects the COE prepared. Kevin did not know except that they only looked at the alternatives that were identified as the "recommended alternatives for further study" and the spiral case taps were not included. I also asked about the statement in the NMFS reviews of the Phase II report that asked the COE to consider traveling screens rather than the screen designs that the COE has shown. Kevin said that they feel that the traveling screen concept is well documented and that it is as complex (or more so) than the designs they depicted since it has a lot of moving parts. Rolf also asked about the NMFS comment in the report that they were concerned about sleeve valves being too noisy and distracting fish. Kevin said they contacted a vendor who

sleeve valves being too noisy and distracting fish. Kevin said they contacted a vendor who said that they were quiet and have some experience with existing valves at Dworshak which, according to staff there, are quiet. This may in fact be difficult to evaluate without hydrophones to record the actual noise signature under water.

21. (See attached trip notes from DCV Consultants for more detail on the pumping equipment at Lower Granite).
22. We left the dam at about 2:30 pm for our trip back to Seattle and other parts.

Prepared By: Rolf G. Wielick
Rolf G. Wielick

Attachments:

- Trip notes from DCV Consultants dated March 6, 2000
- Consolidated list of requested information
- Drawing requests

Distributions:

Meeting Attendees (w/ attachments)
Kevin Crum (Walla Walla) (w/ attachments)
Larry Swenson, NFMS Portland (w/ attachments)
Project Files (w/ attachments)

DCV CONSULTANTS
Electrical and Mechanical Engineering Services

40 Pt. San Pedro Rd., No. 57, San Rafael, CA 94901
Telephone: (415) 457-2739
FAX: (415) 457-2734

March 6, 2000

To: Files
From: Gerald Walker
Subject: COE Task No. 1 – EWAS
Trip Report 2/27/00 – 2/29/00

1. February 27, 2000
   a. Traveled from San Francisco to Walla Walla

2. February 28, 2000
   a. Met Sverdrup team. Traveled to Little Goose
   b. Inspected fish water pumps.
      i. Pump vibrations from less to most: 2, 3, 1. This by feel.
      ii. Pump 1 has a "knock" occurring at rotating speed (~1/sec @ 70 rpm). Plant reports this has been there for some time and cause has not been determined.
      iii. Alarm monitoring for temperatures only. Vibration monitoring not provided. Should be added.
      iv. Monitoring panel located on turbine floor in erection bay. Monitors flows and rpm's (See Picture) Recent Rosemont temperature monitoring panel on side.
      v. Farval grease lube system for pumps and turbines has been replaced with water lube system.
   c. Fish pump operation
      i. Started and stopped manually. If three operating and one shuts down, remaining two are adjusted to reduced gate (60%?).
      ii. Len Reese of COE has recently made flow measurements so should have current curves. Believed to be operating at less capacity than specified.
      iii. Rating: 850 cfs pump @ 4' head with turbine at 90' gross head. 700 cfs pump @ 4' head with turbine @ 95' gross head. Max speeds: 690 rpm turbine=80 rpm pump
   d. Equipment:
      i. Turbine: B-L-H Order No. 500-50204, Contract 65-142, 22" Dia. runner, 13 blades.
      ii. Pump: B-L-H (same order and contract no.), 115" Dia., 3 blades.
      iii. Gear Box: Philadelphia Gear, No. B-141917, Model Size: 3500-25 SBVHX,. Right angle, 8.63:1 spiral bevel-helical. 562 HP @ 690 rpm input, 10^5 hours bearing life @ 562 HP.
      iv. There is a spare gear box on site. It is to be shared with Lower Monumental
   e. Maintenance
      i. Good. Main problems are in instrumentation. Original parts not available.

3. February 29, 2000

a. Traveled to Lower Granite
b. Inspected fish water pumps
   i. Pump No. 1 not in service. Bulkheaded. Believed due to lack of faith in gearbox. Pump has not operated since at least 1995. Therefore, no spare fish water capacity at present.
   ii. Pumps 2 and 3 impellers inspected recently from bottom. No problems noted. Pumps 2 and 3 packing repaired last year. Repaired by building up with epoxy and re-machining. Jim Holsten (Mech O&M) noted packing box is one piece, requiring pulling shaft to fix. He plans to convert to two-piece for ease of maintenance.
   iii. Original contract provided each pump with Falk gear box. In 1978 (Contract 78-C-0063) Falk was replaced with present Philadelphia gear box on Pump 1. <u>Will have to find out why</u>. Pump 1 is two speed with Hitachi motor that appears to be Contractor furnished. Pumps 2 and 3 motors are Ideal and were Government furnished.
   iv. Maintenance period is usually one month starting January 1.
   v. Electrician stated that she had heard that Pump 1 gear box vendor said Anti backspin device is not suitable for loads. Maintenance files show that Chief of Design Branch had stated device was satisfactory and it should be installed. Plant maintenance forces don't believe it is suitable. <u>Will have to investigate this aspect further.</u>
c. Operation
   i. Pumps are started and stopped manually. Controls will auto-start standby pump.
   ii. Problems getting gear box oil temperature up to normal on start. Operator has to baby them along. Oil heaters should be installed. All gear boxes have openings for heaters.
   iii. There is a spare Falk gear box on site.
d. Discussions with Kevin Renshaw
   i. Raytheon report had main turbine spiral case tap as alternative for Lower Monumental. Final report did not address this. Kevin did not remember why it was not addressed or at least reasons stated why it was not addressed. <u>Will have to follow up further with Kevin on this.</u>
   ii. Kevin said their approach for Ice Harbor and Lower Monumental was to accept that alternates discarded in Raytheon report were not to be further studied in final report.
   iii. Shawn Milligan did a report on Pump No. 1. <u>We should get this report.</u>
e. Equipment
   i. Pumps 2 and 3: 1050 cfs @ 4' @ 705 rpm @ motors (Ideal)
   ii. Pump 1: Hitachi motor, 455 cfs @ 4' @ 500 rpm. 1050 cfs @ 4' @ 705 rpm.

Dave Abshar
DCV Consultants

TRIP REPORT

Little Goose and Lower Granite

Monday, February 28th, 2000

Traveled from Seattle to Walla Walla

Traveled from Walla Walla to Little Goose Dam.

The current fish attraction water system uses turbine-powered pumps. There are three pumps in use at all times in order to provide sufficient water. These pumps have sufficient capacity using two pumps, so there is currently no need for back-up pumping capacity. However, the turbine auxiliary systems are in need of modification. The existing control system was installed as part of the original construction contract and hasn't been modified since.

The turbine protective system must have a vibration switch installed on both the turbine and the gearbox. The flow monitoring devices for the turbine/gearbox oil and water flow should be installed or upgraded.

Tuesday, February 29th, 2000

Traveled from Walla Walla to Lower Granite Dam.

Instead of using turbine-powered pumps, the system at Lower Granite uses electrically operated pumps. Again there are three pumps, with two sufficient to provide fish attraction water. But the third, or back-up, pump at this installation hasn't been operational for many years. The pump is apparently down for gearbox problems, and has the discharge closed. The three pumps are currently operated form only one of the 4160 V station service busses. (There is some debate over the actual connection of these devices, which will require additional field investigation. Maintenance personnel state that the pumps are connected to two busses, and the drawings show only one.) So that if this buss is out of service, none of the pumps can be operated. The improvements to this system would involve the installation of manual isolation/connection switches, in order to operate the pumps from either bus.

Part of the problem with the back-up pump is that the standby pumps in this system will rotate backward unless the discharge is blocked. A locking device has been installed on Pump #1, but the current system is poorly designed. A better system would have a flywheel large enough to reach the floor. The flywheel would have holes to accommodate a locking pin. The locking pin would go through a clevis anchored to the floor. The pin would also trip a limit switch, to prevent the pump from starting when the lock is in place.

Again the control and monitoring system is the one installed under the original contract. At the minimum, the pumps should have vibration switches installed, and the flow and pressure switches upgraded. An additional problem with this installation is the installation of oil heaters on the pump gearboxes.

The level monitoring system for the fish passageways in this dam are the ones that were originally installed. The system is very complicated and prone to failure. At Little Goose, the original system has been replaced with an ultrasonic system (Milltronics Hydroranger Plus). The existing system should be replaced with the same system currently in use at Little Goose.

TOTAL P.01

TOTAL P.04

Information Request For Sverdrup Civil, Inc.

Little Goose / Lower Granite EAWS
Task Order No. 1

1. Request Kevin Renshaw review his files to determine why spiral case tap alternative was dropped between Raytheon report and Lower Monumental Phase II report.
2. Request copy of Sean Milligan report on Fish Pump 1 at Lower Granite
3. Request copy of Lynn Reese report of fish pump operation and flows at Little Goose
4. Still some confusion over history of Lower Granite Fish Pump 1.
   a. Originally provided with Falk gearbox.
   b. Philadelphia gearbox with Formsprag backspin device installed in 1978 under Contract 78-C-0063. Don't know why. Is there more information on reasons for change?
   c. Questions raised by COE about capability of Formsprag device (believe 1982). Chief of Design Branch reviewed and approved installation. Anti backspin device still reported by current staff as not suitable. Are there more details available on current unsuitability?
   d. There is a file folder in Mechanical maintenance records file cabinet (top drawer) in office at Lower Granite Dam that covers the early history of Fish Pump 1. It is the thickest of the pump files and I think in a legal size folder. Is it possible to have this folder sent to us for abstraction of pertinent data, then returned to the plant?
5. The latest FPP for Little Goose and Lower Granite Dams (Year 2000)
6. Lynn Reese's hydraulic evaluation of Little Goose with any other hydraulic documentation that Lynn has. (same as Item No. 3?)
7. Sean Milligan's hydraulic evaluation of Lower Granite with any other hydraulic documentation that Sean has (same as Item No. 2?)
8. Pump-turbine (as a function of head differential across the turbine and pumped lift) and pump (as a function of pumped lift) rating curves for Lower Granite and Little Goose.
9. Hydraulic Evaluation of Adult Fish Passage Facilities at Little Goose, Lower Monumental and McNary (southshore) Dams, Corps of Engineers, November 1988
10. Lower Granite Lock and Dam, Fishway General Arrangement Drawings from Water Control Manual
11. Lower Granite Dam Maintenance Records for Fish Pumps 1, 2, and 3
12. (Draft or Final?) Hydraulic Evaluation of Adult Fish Passage Facilities at Lower Granite Dam, Hydraulic Design Section, Walla Walla District, US Army Corps of Engineers, July 14, 1995
13. Any other hydraulic evaluations done for fishway systems at either dam.

Gerry W. Col 3, Row 11 DWS Request G to Wallace 2/25/01

GDP-1,11-3-4/1
4/2
4/3
4/6
4/7

GDP-1-0- 0/3
0/4
0/6

GDP-1-3- 1/12

SK-GDP-070

03-152-0161-4 (Philadelphia Gear)

Fishway Pump Repair

Dwg file: Folio Column 3, Row 11

[redacted]erdrup

Job No.	By	Subject	Sheet
Date	Checked	Lower Granite	Of

Dwgs ~~LGD~~ GDD-1-4-2/1 South non-overflow
2/2
2/1.1
2/3
2/4
2/5
2/6
2/7
2/8
2/9
2/9.1
GDF ~~G~~ 1-0-3/1 Ladder
3/2
3/5
3/6
3/7
3/9

~~Lower Granite~~

4160+480V 1-LINE	GDN-1-6-14/7
MAIN 1-LINE	GDP-1.5-6-9A21/3A
~~GDU~~ CONTROL SOURCES 1-LINE	GDP-1.5-6-9A23/1
UNIT 1-LINE	GDP-1.5-6-9G21/1
MAIN UNIT POWER CENTERS	GDP-1.5-6-1A21/5
	GDP-1.5-6-1A21/4
1-LINE " SU4+EP4	GDP-1.5-6-1F21/1
1-LINE SQ1+SQ2	GDP-1.5-6-1G21/1
CABLE ARRANGEMENT 4.16K POWER	GDP-1.5-6-1A11/4
Powerhouse Gen Bay	GDP-6-0-0/8
1-Line STA Auxiliaries	GDP-1-6-1A21/3
~~MAIN 1-LINE~~	~~GDP-1-6-9A21~~
1-LINE STATION SERV	GDP-1-6-1A21/2
1-LINE SQ0, SQ1, CP0	GDP-1-6-1D21/1

Sverdrup

Job No.	By	Subject	Sheet
Date	Checked	Little Goose	Of

LGD-1-4-2/1 S. Non-overflow
" " " 2/2

LGD-1-4-2/14 N. non-overflow
2/15
2/15.1
2/17
2/24
15/1
2/18
2/19
2/20
2/21
2/21.1 - 2/21.5

LGN-1-4-2/13 Monolith 4
2/14
2/15
2/16
2/17

2-28-00

Little Goose

? Multronics level transducers
Level control system

1-Line Station Service	LGP-1.1-6-1A21/2
1-Line Main Unit Power Centers	LGP-1.1-6-1A21/4
1-Line SQ0 SQ1 + CP0	LGP-1.1-6-1D21/1
1-Line CQ01 CQ02 FCQ2	LGP-1.1-6-1D21/2
1-Line CQ03, CQ04 CQ05	LGP-1.1-6-1D21/3
Control Diagrams Station Service Aux Sht 1	LGP-1.1-6-1D24/1
Control Diagrams Station Service Aux Sht 2	LGP-1.1-6-1D24/2
Control Sources 1-Line	LGP-1.1-6-9A23/1
480V Substation SQ0	LGP-1.1-6-1A8/1
480V Substation SQ1	LGP-1.1-6-1A8/2
480V Control Centers CQ01, CQ02, CQ04, CQ05	LGP-1.1-6-1A8/3
480V Control Centers SU1 thru SU3	LGP-1.1-6-1A8/4
South Shore Fish Facilities FSC SWBD Control Panel Layout	LGP-1.1-6-9A60/3
Temporary Fishwater Pumping Installation	LGP-1.1-6-1D11/2

Sverdrup

Job No.	By RGWS	Subject	Sheet ____
Date 2/29/00	Checked		Of ____

Lower Granite Dwgs.

GDP-1-4-0/1 thru 0/8

GDP-6-0-0/1 & 0/2

GDP-6-0-0/8, 0/9 & 0/10

GDP-1-1-0/3

GDP-1-4-3/1, 3/2, 3/3 thru 3/20

Little Goose Dwgs.

LGP-6-0-0/7, 0/8, 0/9

LGP-1-5-2/29

LGP-1-4-0/1 thru 0/8

LGD-1-4-2/5 thru 2/8

LGF-1-0-3/1

LGF-1-4-3/12

LGP-1-1-0/4

LGP-1-4-2/1 & 2/2

LGP-1-4-2/22 thru 2/27

LGP-1-4-3/1 Thru 3/21

Review Comments

Project: Gr/Goose EAWS-Phase II Tech Rep 30% **Location:** Granite/Goose

Date: 25-Aug-00 **Reviewer: Van D. DeWitt** **Telephone: 509-527-7562**				**Page 1 of 1**
XX NPW-EN-DB-EL __ Air Force __ Army **Design Document**: __ D. Memo, __ P&S, 30% Tech Report, __ Concept, __ Prlim., __ Final **Discipline**: __ Arch., __ Civ., XX Mech/Elect., __ Struct.		**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	**Drawing Sht. Spec. Para.**	**COMMENTS**	Action taken on Comments by: Rolf Wielick	

Item No.	Drawing Sht. Spec. Para.	Comments	Review Conference	Design Office	Back Check
1.	General	This submittal is a good start, but is not considered at 30%. There are no 30% drawings and text provided is mostly a summary of field trip results and repeat of text in Phase I report.	**A -** Please see Comment Response for Item No. 2 for Ron Porter. Please note that our conclusions as to the status of the systems at Lower Granite and Little Goose are different than presented in the Phase I report in significant and important ways and drastically change the nature of the project.		
2					

Review Comments

Project: Gr/Goose EAWS-Phase II Tech Rep 30% **Location:** Granite/Goose

Date: 5/10/00 **Reviewer:** Ron Porter **Telephone:** 509-527-7519

XX NWW-ED
__ Air Force
__ Army

Design Document	Discipline
__ D. Memo	__ Concept __ Arch.
__ P&S	__ Prlim. _X_ Civ.
X 30% Tech Report	__ Final __ Mech/Elect.
	__ Struct.

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (If neither, explain)	DESIGN OFFICE C-correction made (If not, explain)	Back Check By: (initials)
1.	General	Examination of Alternatives – While the SOW indicates that Phase I alternatives need to be investigated and defined in Phase II, it does not indicate that only those Alternatives should be investigated. This is especially the case in light of the problems with the Phase I Report, in other words, do not rely on the Phase I Report as the sole source of guidance going into Phase II. Since the Spiral Case Tap was eliminated from the 30% Draft list of Alts., it would seem that those priced hours should be applied to brainstorming new ideas and forming a more comprehensive set of Alts. Then the Phase II report can discuss those Alts. that are not considered viable, eliminate some, and address the good ideas in more detail in this Phase II report. (The examination/brainstorming of Alts. is important in light of the fact that the IH/LoMo Phase II Report did not propose/describe the Alt. that is actually being selected for the EAWS final design at LoMO.) It is possible that no other viable Alts. exist outside of the Phase I list, but doubtful. NMFS was/is also concerned that viable options were not being investigated beyond the Phase I list.	**A** – The listing of alternatives in the 30% submittal to be reviewed, is a "place holder" and is tentative at best. The intent is to review the Phase I report alternatives and assess their feasibility, and eliminate or modify ones that do not seem feasible or meet project objectives. For example, pumping from the tailrace seems to be viable. Pumping from the north shore and piping the water to the south shore does not. We intend to modify the alternatives as required. If a Phase I alternative is eliminated, we will credit the hours not used in developing that alternative towards other alternatives. As you might notice, the price proposal was developed specifically with the Phase I alternatives in mind, per the SOW, and our ability to fully develop other alternatives (to a Phase II – Technical Report level) is, of course, limited by the total number of hours we allocated for the project.		
2	General	The 30% submittal should include drawings and text at the 30% level. This submittal does not have drawings at this level – text??.	**A** – The 30% report was intended to accomplish two primary goals. Those were 1) to evaluate the existing systems at Goose and Granite from a mechanical,		

Review Comments — Project: Gr/Goose EAWS-Phase II Tech Rep 30% — Location: Granite/Goose

Date: 5/10/00 **Reviewer:** Ron Porter **Telephone:** 509-527-7519

XX NWW-ED
__ Air Force
__ Army

Design Document
__ D. Memo
__ P&S
X 30% Tech Report

Discipline
__ Concept __ Arch.
__ Prlim. _X_ Civ.
__ Final __ Mech/Elect.
__ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
			electrical, and hydraulic/fisheries viewpoint, and 2) to identify any shortcomings to meeting operating criteria and/or maintenance issues. Establishing these items sets the stage for the rest of the report. For example, we determined that at Goose the AWS system does not have any spare capacity and that 3 pumps are required to meet FPP criteria. This is in contrast to the Phase I report that said that only two pumps were required and that one pump was available as spare capacity. We need concurrence with this at 30% to proceed to 60% because that information shapes the nature of the discussions and concepts in the rest of the report. At Lower Granite, we were able to establish that 2 pumps are required to meet FPP criteria and that the third pump (Pump No. 1) has not been operated in 5 years and that at least some of the project staff at Lower Granite that we talked to are of the opinion that it is defective. This is in contrast to the Phase I report that says that all pumps are available with no hint of any concerns about the third pump. We need		

Review
Comments   Project: **Gr/Goose EAWS-Phase II Tech Rep 30%**   **Location:** Granite/Goose

Date: 5/10/00   **Reviewer:** Ron Porter   **Telephone:** 509-527-7519

XX NWW-ED
__ Air Force
__ Army

Design Document
__ D. Memo
__ P&S
X 30% Tech Report

Discipline
__ Concept __ Arch.
__ Prlim. _X_ Civ.
__ Final __ Mech/Elect.
__ Struct.

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (initials)
			to establish the viability of all three pumps to proceed with concepts to increase reliability of the pumps. It is particularly important to get concurrence with your staff that the fishways at both projects are currently operating in a manner that meets agency and COE biologists expectations. If the existing systems are undersized to start with, adding redundant capacity to undersized systems seems pointless.		
3	Para. 2.2.2	If additional information in a future site visit is needed, it should be scheduled now.	**A** – We are in the process of scheduling that visit. Concurrence with the findings in the 30% report is important in shaping the nature of the additional site visit in terms of what needs to be reviewed.		
4	Para. 2.3.1	Not clear if a 25 year life is suitable for old and new designs, or if an additional 25 years is possible with good maintenance of old systems.	**A** – In evaluating the existing systems, we are saying that one of the criteria for the existing systems is that they should be viable for an additional 25 years with continued good maintenance in order for them to be considered to be acceptable as reliable components of the system. New systems should be designed for 25 years with appropriate maintenance.		

Review Comments Project: Gr/Goose EAWS-Phase II Tech Rep 30% Location: Granite/Goose

Date: 5/10/00 **Reviewer:** Ron Porter **Telephone:** 509-527-7519

XX NWW-ED
__ Air Force
__ Army

Design Document
__ D. Memo
__ P&S
X 30% Tech Report

Discipline
__ Concept __ Arch.
__ Prlim. _X_ Civ.
__ Final __ Mech/Elect.
__ Struct.

REVIEW CONFERENCE — A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE — C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
5	P. 4.2.2.1	When describing fishway performance indicate the acceptable criteria that is not being met, as listed in para. 2.3.3.2.	**A** – The text will modified to add this reference.		
6	P. 4.2.2.2	Again is normal life 25-40 years for the pumps, but NWW can expect 50-60 years, because of good maintenance?	**A** – Yes.		
7	Section 5	Good discussion of Granite – but some of the same issues as Goose need to be addressed. Do you want a test of Pump #1 conducted?	**A** – We are unclear as to which issues appear to be missing. The intent of the 30% submittal was to develop discussions on both projects to the same level of detail and completeness. Clarification is requested. Yes, we feel that a test of Pump No. 1 is critical for completing our evaluation in the report.		

Review

Comments Project: Granite/Goose P2 EAWS Location: L. Granite/L. Goose

XX NPW-EN-DB-HY __ Air Force __ Army		**Design Document** / **Discipline** __ D. Memo __ Concept __ Arch. __ P&S __ Prlim. XX Civ./Hydr. 30% Rpt __ Final __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(If neither, explain)**	**DESIGN OFFICE** **C-correction made** **(If not, explain)**	Back Check By: (Initials)
Date: May 11, 2000		**Reviewer: Sean Milligan Telephone: (509) 527-7535**	**Page 1 of 3**		
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson		
1.	General	Seems to be a number of typos throughout the report. Suggest careful proofreading before submitting final draft.	**A** – We hope that the typos you refer to are only in engineering-type terms such as "headloss" where engineers tend to be somewhat creative. The document was reviewed with a "spell checker" prior to issuance. We will confirm the spelling integrity.		
2.	General	Once you identify an acronym or abbreviation, you don't need to continue to write out the full reference (*e.g.* Lower Granite Lock and Dam – just Lower Granite is fine).	**A** – Yes. That was our intent.		
3.	1.1	Last Para. Replace Ice Harbor with Lower Granite.	**A** – Yes		
4.	2.3.1	1st two sentences. This is an issue that may require more discussion, but in the past I think we've decided that our goal is to provide emergency backup capacity of one pump equivalent such that if one pump goes out, the system can operate with no loss of capacity compared to how the system normally operates, which is not necessarily the same as saying the system would stay within FPP criteria. Our current systems are not necessarily always within FPP criteria under all conditions.	**A** – Yes, you are right. In fact, in our evaluation of the performance of the fishways at both Granite and Goose, we note that criteria is not met at the north shore entrances (insufficient head differential across the entrance weirs) and at various locations in the fish channels due to low velocities. This will be reworded to note this.		

Review Comments   Project: Granite/Goose P2 LAWS   Location: L. Granite/L. Goose

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. 30% Rpt __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)

Date: May 11, 2000 Reviewer: Sean Milligan Telephone: (509) 527-7535

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson		
5.	Section 3	What's going to be in this section? Design and cost estimates of what?	**A –** It is intended to describe the methodology behind development the design and the cost estimates. Obviously, at this level of detail, some things cannot possibly be evaluated and accounted for. There are likely to be items that will only be identified in final design. We want to cover the major items so that a good cost estimate can be developed.		
6.	4.2.1.1 & 5.2.1.1	2nd to last sentence. Reword this sentence to make it clear this is an extension of the powerhouse collection channel, not a water supply gallery.	**A –** Yes.		
7.	4.2.2.1	Says flow is supplied from 3 sources, then only two bullet items listed – is the turbine discharge the third source?	**A –** The turbine discharge used to be the third source but was combined with the total discharge of the pumps as it is presented in other documents. The text will be changed to "two" sources.		
8.	4.2.2.2	2nd para. When one of the pumps shuts down, do you mean the remaining turbine units (not pump units) go to 60%? Also, I think it's the wicket gates that move to reduce the opening, not the guide vanes. In the last sentence, again, it's the increased head on the turbines, not the pumps.	**A –** Yes, turbine units. Yes, wicket gates. Yes, turbines. The text will be revised.		
9.	4.2.2.2	Last para. on p. 4-5: Define acronym OEM. Is this supposed to be O&M? Same for Section 5.2.2.2	**A –** OEM stands for Original Equipment Manufacturer. We will update the acronym list.		
10.	Sect. 4	May want to consider another alternative similar to the new preferred alternative for LoMo (since the turbine/pump systems are identical), which is to replace the turbine-driven pumps with larger or faster electric motor-driven pumps such that 2 pumps will have the same capacity as the existing 3 pumps, leaving 1 pump extra.	**A –** Yes, already talked to Ron Porter about that.		

Review Comments Project: Granite/Goose P2 EAWS Location: L. Granite/L. Goose

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document**: __ D. Memo; __ P&S; 30% Rpt; __ Concept; __ Prlim.; __ Final **Discipline**: __ Arch.; XX Civ./Hydr.; __ Mech/Elect.; __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Date: May 11, 2000 Reviewer: Sean Milligan Telephone: (509) 527-7535		**Page 3 of 3**		

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson		
11.	5.2.2.2	3rd para. on p. 5-6: Note that during the operation of all three pumps at normal tailwater, with Pump 1 at low speed, it is true all three pumps seemed to operate fine, but this was just a short duration test, maybe 3 or 4 hours. I agree with the statement in the previous paragraph that Pump 1 should be operated for a longer duration to verify its suitability for service, especially since the project personnel seem to have their doubts. If there are problems with Pump 1, one of the alternatives should include doing whatever is necessary to get it back up to snuff. Even if Pump 1 is in good condition though, I don't think it's a good idea to try and run it at low speed in combination with the two other pumps at low tailwater. There just isn't enough diffuser capacity to handle that much water so the pumped head with increase.	**A** – We agree. We will incorporate your thoughts into the text. Thanks.		
12.	App. A	Some of the dates in the Major Project Milestones section seem to have the wrong format.	**A** – Yes. Thanks for noting that. I don't know what happened to it…Darn computers…		
13.					

Technical Review Comments

Project: Granite and Goose EAWS **Location:** Granite and Goose Dams

Date: 5/10/00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
__ Air Force
__ Army

30%Comments_KR

Design Document: __ D. Memo, __ P&S, __ 50%, __ Concept, __ Prlim., __ Final

Discipline: __ Arch., __ Civ., __ Mech./Elect., X Tech, __ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (If neither, explain)

DESIGN OFFICE: C-correction made (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, and Jerry Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (Initials)
1	1-1	Paragraph 1.1. Paragraph appears to reference Ice Harbor instead of Lower Granite in the last line.	**A** – This will be corrected.		
2	1-2, 4-7,4-8	Alternatives discussions. This phase 2 report appears to be addressing all the alternatives that were originally addressed in the phase 1 report for Little Goose and Lower Granite, except, the spiral case tap was not mentioned in section 4. If the intent is to address all the phase 1 report alternatives in more detail in phase 2, some discussion of the spiral case tap would be in order. It is mutually understood, I assume, that the "no action" alternative is not acceptable.	**A** – The SOW requires that the alternatives identified in the Phase I report be reviewed. We intend to modify, eliminate, or add alternatives as necessary. The list of alternatives contained in the text is a placeholder in this document. Final alternative selections will be identified and developed between 30 and 60%. We will note in the text that the spiral case tap is being dropped and why. All alternatives will be addressed. Some, like potentially the "no-action" alternative, will likely be dropped.		
3	2-4 5-6	Second paragraph under 2.2.2. Ninth paragraph under 5.2.2.2. None of the pumps at Lower Granite were in operation on February 29, 2000 (at least while I was there). The wording of the paragraph makes it sound like pump 1 at Lower Granite was the only pump that was not operating. The pumps at Little Goose were operating on February 28, 2000, according to the included trip reports.	**A** – It does seem to read that way. This will be clarified in the text. None of the pumps were running. That is one of the reasons we would like to revisit the projects.		

Technical Review Comments

Project: Granite and Goose EAWS **Location:** Granite and Goose Dams

Date: 5/10/00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
__ Air Force
__ Army

30%Comments_KR

Design Document: __ D. Memo, __ P&S, __ 50%, __ Concept, __ Prlim., __ Final

Discipline: __ Arch., __ Civ., __ Mech./Elect., X Tech, __ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (If neither, explain)

DESIGN OFFICE: C-correction made (If not, explain)

Action taken on Comments by: Rolf Wielick, Perry Johnson, and Jerry Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check By: (Initials)
4	2-4	Paragraph 2.3. Should confirm whether the 1998 FPP is what the reference is, or whether a later version is intended.	**A -** The 2000 FPP is used in the report. The text will be corrected.		
5	4-3	Second Paragraph under 4.2.1.2. Appears to be confusion referencing the south shore pumphouse in the erection bay.	**A -** The text will be modified to clarify this.		
6	4-3 5-4	4.2.2.1 and 5.2.2.1. Not real clear from the text. On any given pump operating at constant speed, an increase in head will result in a decrease in flow. There is an implication that the head loss in the system is greater than it was supposed to be. It would seem that if there were leaks, the actual pump flow output would go up, which means the pump head would go down. If the leaks are plugged, the actual pump output will go down. Some of the possible reasons seem to be mutually exclusive. Also, if the errors were in the evaluation process, this might not mean there was a shortfall, therefore this possible reason would not apply. Our ability or inability to measure it accurately does not affect the actual system flow.	**A -** Discussion with Project personnel at Little Goose indicated that a possible cause of reduced flow supply to the north shore fishway entrances is the complex configuration of the conduit that supplies the north shore diffuser. We do not know if actual losses exceed values expected from the initial design. Likewise we have not attempted to evaluate these losses. However we note that if losses were reduced, then current flow rates could be supplied with a reduced lift. This would balance against pump output which would increase with reduced lift. The system would stabilize at a flow rate that is higher than that currently		

Technical Review Comments

Project: Granite and Goose EAWS **Location:** Granite and Goose Dams

Date: 5/10/00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
__ Air Force
__ Army

30%Comments_KR

Design Document
__ D. Memo __ Concept
__ P&S __ Prlim.
__ 50% __ Final

Discipline
__ Arch.
__ Civ.
__ Mech./Elect.
X Tech
__ Struct.

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (If neither, explain). Action taken on Comments by: Rolf Wielick, Perry Johnson, and Jerry Walker	DESIGN OFFICE: C-correction made (If not, explain)	Back Check By: (Initials)
			generated. With respect to the influence of leaks, a specific discharge is supplied when the pumps are operating with a specific lift. If a portion of this discharge is lost to leakage, then less flow is supplied to diffusers and fishway entrances. If leaks are sealed the resulting pumped lift would increase and stabilize at a reduced total pumped flow rate but with increased flow supplied to desired locations. With respect to the accuracy of flow rate evaluations and our corresponding knowledge of supplied discharges, you are correct in that this does not change actually occurring performance. However it is not clear what flow rates are generating the current performance.		

Technical Review Comments

Project: Granite and Goose EAWS **Location:** Granite and Goose Dams

Date: 5/10/00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
__ Air Force
__ Army

30%Comments_KR

Design Document
__ D. Memo __ Concept
__ P&S __ Prlim.
__ 50% __ Final

Discipline
__ Arch.
__ Civ.
__ Mech./Elect.
X Tech
__ Struct.

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (If neither, explain)	DESIGN OFFICE C-correction made (If not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Rolf Wielick, Perry Johnson, and Jerry Walker		
			Consequently if additional capacity is supplied in conjunction with this study, the added capacity may be no more then an emergency backup or it may offer increased flow with improved performance.		
7	Meeting Minutes	Should get the correct spelling of the personnel names in the minutes. Not sure how the flywheel-locking pin arrangement could be made automatic engaging like typical anti-reverse-rotation devices are. May want to consider valves to prevent backflow like Ice Harbor has. This would facilitate quick changing between pumps.	**A -** The spellings in the attendees lists are the spellings as we understand them. We of course attempt to get all names spelled correctly and would appreciate any corrections. We will establish a time criteria for changing between pumps with the plant operators. If the current bulkhead removal time is not within their requirements, alternates, such as the installation of valves or dedicated bulkhead hoists will be investigated.		

Technical Review of Adult Fishway Systems EAWS Phase II – Technical Report Comments

Project: LGO & LGR Location:

Date: Jun. 22, 2000 **Reviewer: David Embree** **Telephone: 509-843-1493 ext 245**

Office	Type of Design Document	Discipline		DESIGN OFFICE	Back Check By:
Eastern Projects	D. Memo / Concept Report / P&S 100% / Prelim. / **30%**,60%,90% / Final	Engineering		C-correction made (if not, explain)	(initials)

Comments transcribed from Charlie Krahenbuhl notes

Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken	C-correction made (if not, explain)	Back Check By (initials)
1	4.2.2.2 para 1 pg 4-4	Please verify actual year in which LGO "equipment was placed into service in 1972…" Was this 1970?	**A** - Not sure. The "As Built" date on drawings was used. This will be verified.		
2	4.2.2.2 para 2 pg 4-4	Please verify that following a LGO fish pump turbine trip the remaining two operating pump "automatic controls *reduce* the guide vane openings … to 60%." Is the vane openings increased or reduced during this transition?	**A** - Per plant operators: reduced to limit turbine speed rise due to higher head		
3	4.2.2.2 para 6 pg 4-5	How will rebuilding or refurbishing components effect normal service life? If components are rebuilt will age still be a factor? How will having spare components such as spare gear effect service life?	**A** - Normal life, per ER37-2-10 is only a guide, used for evaluating investment options. Actual life is based on condition, including parts replaced with new, and level of maintenance. Estimated actual life, based on the above, is another 25 to 30 years. Believe this has been clarified in 60% report		
4	4.2.2.3 para 1 pg 4-6	Consider a fail-safe configuration that will either lockup or shutdown the system.	**A** - This will be reviewed.		
5	4.2.3 para 2 pg 4-6	The most likely duration of the operational period for fish attraction flow is from <u>March</u> to <u>December</u>.	**A** - Yes, thank you.		

Technical Review of Adult Fishway Systems EAWS Phase II – Technical Report Comments   Project: LGO & LGR   Location:

Date: Jun. 22, 2000   **Reviewer: David Embree**   **Telephone: 509-843-1493 ext 245**

Office	Type of Design Document		Discipline
Eastern Projects	D. Memo	Concept Report	Engineering
	P&S 100%	Prelim.	
	30%,60%,90%	Final	

Comments transcribed from Charlie Krahenbuhl notes

DESIGN OFFICE — **C-correction made** **(If not, explain)** — Back Check By: (Initials)

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson	DESIGN OFFICE C-correction made (If not, explain)	Back Check By: (Initials)
6	5.2.2.2 para 6 pg 5-5	The fact that the pump has not been operated and has been isolated as required by the present operational lineup is not the same as being unavailable. Recommend inserting statement from project management describing pump availability if another pump were to fail.	**A** - The issue of availability relates to our understanding that there are mechanical issues related to Fish Pump No. 1 that made it "unavailable" as we note on in the second bulleted item in Paragraph 7 in Section 5.2.2.2 (page 5-6). You are right that simply being not operated and bulkheaded does not mean it is "unavailable". This will be clarified and refined at the 60% submittal.		
7	5.2.2.2 para 9 pg 5-6	"This can be expected as the power requirements, and thus motor currents, increase at increasing head." This conclusion is contrary to physics for non-positive-displacement pump/motor operation. Cause of overheating may have been too many starts or pumps operating with too low a discharge head (near runout). Please clarify. (comment by David Embree)	**A** – Perry – With low tailwater the flow depths in the fishway channels are reduced, hydraulic radius decreases, head losses increase. Thus more lift is required. This combined with reduced pumped discharge could yield over heating. Also, the B-L-H Curve F-15948 shows flow dropping as head rises. Curve also shows power requirments increasing as head rises and flow drops off.		
8	5.2.2.2 para 9 pg 5-6	"Three pump operation should only be attempted at higher tailwater conditions." Note: Idaho Fish & Game relooking at MOP insistence. Contact Charlie Krahenbuhl for more details.	**A** - We would appreciate clarification of this comment.		
9	5.2.2.3 para 1 pg 5-7	"…however plant personnel and drawings at the site indicated that there is only one source." The drawings show two power sources. Please correct.	**A** - This is being corrected in the 60% report.		

Technical Review of Adult Fishway Systems EAWS Phase II – Technical Report Comments   Project: LGO & LGR   Location:

Date: Jun. 22, 2000   **Reviewer: David Embree**   **Telephone: 509-843-1493 ext 245**

Office	Type of Design Document		Discipline		DESIGN OFFICE	Back Check By: (Initials)
Eastern Projects	D. Memo P&S 100% **30%**,60%,90%	Concept Report Prelim. Final	Engineering		**C-correction made** **(if not, explain)**	

Comments transcribed from Charlie Krahenbuhl notes

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick, Gerald Walker, Perry Johnson		
10	5.2.2.3 para 2 pg 5-7	"… level monitoring and control system replaced with modern equipment." Please verify current status.	**A** - This will be verified.		
11	5.2.3 para 3 pg 5-8	"The reliability of electrical power supply to the motors is not acceptable, regardless of the final disposition…." This is vague and does not clearly state the problem. Please re-word.	**A** - This is a summary of our findings in Section 5.2.2.3. The next sentence which reads "This is due to the lack of redundancy of the power supply to the motors and the potential for a single-mode failure via an electrical fault in the electrical equipment enclosure." does in our opinion.		

DCV CONSULTANTS
Electrical and Mechanical Engineers

40 Point San Pedro Road, No. 23, San Rafael, CA 94901
Telephone: (415) 457-2739
Fax: (415) 457-2734
Email: DCVConsult@aol.com

May 19, 2000

TRIP REPORT

Date: May 16 and 17, 2000

Place: Little Goose (May 16) and Lower Granite (May 17) Dams

Subject: USACE Walla Walla District – Contract No. DACW68-99-0003
Task Order No. 1 – Little Goose / Lower Granite Emergency Auxiliary Water System (EAWS()
Site Visit – Data Gathering

<u>May 16, 2000 – Little Goose Dam</u>

ATTENDEES:

Phil Rider	USAACE	Mechanical Forman
Kevin Goe	USACE	Electrical Forman
David Embree	USACE	Electrical Engineer
Rex Baxter	USACE	Project Fisheries Group
Gerald Walker	Sverdrup/DCV Consultants	Mechanical Engineer
David Absher	Sverdrup/DCV Consultants	Electrical Engineer

MINUTES

1. The site visit was to gather additional data and expand on questions arising from reviews of project documents obtained on the February 28, 2000 site visit.

2. A current study at Lower Monument would replace the existing turbine drivers with electric-motor-driven drivers. Little Goose also uses turbine drivers so the possibility of adding two circuits to the existing 5 kV switchgear (SQO) to accommodate electric drivers at Little Goose was investigated.. Another purpose was to investigate the current 480 V power-supply for the existing turbines.

3. The 5 kV switchgear has sufficient overall capacity to power three 800 HP motors. The line up currently does not have any spaces to install new circuit breakers, but upcoming revisions to the 5 kV power distribution system could leave space for two spare breakers. If not, there is sufficient floor space and overall capacity install new switchgear to hold the new breakers.

4. The replacement of the turbines with electric motors was discussed with the site personnel. The consensus among the site personnel was that the current turbines are very good sources of power for the pumps, mainly due to the low maintenance aspects of this type of machine. The main complaints were with the auxiliary systems. Generally the turbines are set to the desired flow, and left at one position until they are

40 Point San Pedro Road, No. 23, San Rafael, CA 94901
Telephone: (415) 457-2739
Fax: (415) 457-2734
Email: DCVConsult@aol.com

shut down at the end of the season – usually 9 months. Adjustments are required so seldom that the turbine wicket gates stick in place, and changing the gate position can take several hours. This can be a serious problem when a pump fails and a change from three-pump to two-pump operation is required. A solution is to replace the Limitorque operator with hydraulic cylinders and a pump set with accumulators. This type of system would provide stored energy in order to operate the system during power failures. The controls could be designed to provide an automatic change from three-pump to two-pump operation, eliminating any disruption in the flow. The replacement system would eliminate the problem with the wicket gates sticking. An alternate would be to require operators to frequently adjust gate positions for short intervals.

5. Another problem is cold oil after the pump has been at rest. This could be improved through the addition of heaters to the gearbox.
6. Discussed installation time for removing and setting isolating bulkheads in fish pump slots. About three hours during normal weekday day shift; about 7 hours at other times due to calling out crew and mobile crane operator.
7. When a fish pump fails, plant operator adjusts weirs for lower flows. Weir adjustment takes about an hour.
8. Rex Baxter said a 24 hour timeframe to make emergency repairs is acceptable. He realizes a major failure of a turbine, speed reducer or pump could not meet the 24 hour requirement.
9. Phil Rider stated that operation with two fish pumps will meet project needs.
10. Reviewed project Preventative Maintenance records for the fish pumps. Requested some specific reports referenced in the records but they could not be located. Will make further request when we return to home office

DCV CONSULTANTS
Electrical and Mechanical Engineers

40 Point San Pedro Road, No. 23, San Rafael, CA 94901
Telephone: (415) 457-2739
Fax: (415) 457-2734
Email: DCVConsult@aol.com

May 17, 2000 – Lower Granite Dam

ATTENDEES:

Dick Hammer	USACE	Maintenance Forman
Marty Mendiola	USACE	Maintenance Supervisor
Jim Holston	USACE	Mechanical Forman
Gerald Walker	Sverdrup/DCV Consultants	Mechanical Engineer
David Absher	Sverdrup/DCV Consultants	Electrical Engineer

1. The revisions to the power distribution system for improved reliability were discussed with the plant maintenance personnel. The current system has one circuit powering Pump #1, and another breaker feeding Pumps #2 and #3. Each circuit is fed from two separate identical breakers. The breakers are connected to separate busses. The easiest modification would be to connect all the pumps to both breakers, with only one connected at a time. This and additional circuitry and protective relays would transfer automatically between the two busses upon failure of the one currently in use.
2. The Portland office of the COE is currently in the process of re-designing the 5 kV power distribution system, and replace the 5 kV switchgear. This would be an opportune time to incorporate these changes into the new switchgear. We will find out what Portland is doing and how it may affect our study.
3. It would be possible to separate the motor starters, however it would not improve the reliability of the system. The most typical problem has been the loss of the control power transformer. A solution to this would be to convert the gear to 125 VDC
4. As with Little Goose, Lower Granite speed reducers are difficult to get operational when the oil is cold. They should be fitted with heaters for the oil.
5. The fish way level controls should be upgraded to match that found at Little Goose.
6. Plant personnel have further investigated the status of Pump No. 1 they say the pump is operational and ready to go. However, when not operating, the isolating bulkhead must be installed. Backflow through the pump causes the Formsprag backspin device to slip, jarring the pump and speed reducer. The slip is not continuous, rather in discrete jumps. We will discuss the situation with Formsprag. From a document review, it appears that there have been two or three different anti-backspin devices used. This only occurs on Pump No. 1 with the Philadelphia speed reducer. Pumps 2 and 3 have Falk speed reducers which incorporate anti backspin devices.
7. Discussed changeover of fish pump bulkhead gates. Timeframe is the same at Lower Granite as at Little Goose.
8. Obtained copies of two reports:

   a. *Lower Snake River Hydro-Projects – Upstream Migrant Fish Attraction Auxiliary Water Pumping System – Gear Reducer Reliability Report. September 1983, by NPD Hydro-Electric Design Branch.*

40 Point San Pedro Road, No. 23, San Rafael, CA 94901
Telephone: (415) 457-2739
Fax: (415) 457-2734
Email: DCVConsult@aol.com

Report discusses speed reducer problems and proposes alternates for improving reliability as well as proposing alternate sources of auxiliary fish water.

b. *Turbine Drive Feasibility Study – Little Goose / Lower Monumental Fishwater Pumps, September 1, 1989, by NPD Hydroelectric Design Center.* Study discusses turbine problems at both plants, proposes upgrades, and investigates electric motor drivers.

Sverdrup Civil, Inc. Northwestern Region/Seattle

July 25, 2000
X310 01 MM 002

MEETING MINUTES

DATE: July 18, 2000

TIME: 9:10 AM – 2:10 PM

PLACE: USACE Walla Walla District Conference Room - Walla Walla, WA

SUBJECT: USACE Walla Walla District - Contract No. DACW68-99-D-0003
Task Order No. 1 – Little Goose/Lower Granite EAWS
60% Submittal Review Meeting

ATTENDEES:

Name	Company	Phone Number	Location
Ron Porter	USACE - Walla Walla	(509) 527-7519	Walla Walla, WA
Van DeWitt	USACE - Walla Walla	(509) 527-7562	Walla Walla, WA
Sean Milligan	USACE - Walla Walla	(509) 527-7535	Walla Walla, WA
Lynn Reese	USACE - Walla Walla	(509) 527-7531	Walla Walla, WA
Jon Lomeland	USACE - Walla Walla	(509) 527-7652	Walla Walla, WA
Kevin Renshaw	USACE - Walla Walla	(509) 527-7570	Walla Walla, WA
Dave Hurson	USACE - Walla Walla	(509) 527-7125	Walla Walla, WA
Ray Eakin	USACE – Little Goose	(509) 399-2233	Little Goose Dam
Rolf Wielick	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA
Perry Johnson	ENSR	(303) 697-1989	Morrison, CO
David Absher	DCV Consultants	(206) 669-4833	Seattle, WA
Gerald Walker	DCV Consultants	(415) 457-2739	San Rafael, CA

MINUTES:

1. The following is a summary of the discussions and significant issues raised during the review meeting as required in the Scope of Work for Task Order No. 1. The purpose of the meeting was to provide comments and engage in discussions regarding the 60% Draft Report submitted by Sverdrup to the Corps. These minutes will serve to outline the meeting. Detailed comments were provided to Sverdrup via the standard Corps review form (Form 32). For the most part, this meeting involved the discussion of these written comments and other verbal comments provided by reviewers who had not yet submitted formal written ones. The completed forms have been attached and serve as the formal response vehicle for the written comments. Reference will be made to this form in these minutes and Sverdrup's responses will not be repeated in this text. Responses to verbal comments will be addressed separately.

2. Ron distributed a copy of the agenda for the meeting (copy attached) and then began with introductions of the meeting participants. From Ron's agenda, we looked at Item 1a, the status of the station service capacity at Little Goose relative to Alternatives 2 and 3 in the draft report. Rolf led off the discussion by noting that this may have become a less critical issue than originally thought since HDC had recently provided us information suggesting that the following excess capacity existed at Goose and Granite:

Little Goose:	Bus 1: 878 kVa (excess capacity)
	Bus 2 : 1181 kVa (excess capacity)
Lower Granite:	Bus 1: 2471 Kva (excess capacity)
	Bus 2 : 2064 kVa (excess capacity)

The consequence of this is that for Alternative 2 (the new pumped intake at the tailrace deck), the four 300-hp pumps, which draw around 1000 kVa together. This could be taken in total by Bus 2 or split between Bus 1 and 2. For Alternative 3, which would add two 700 to 1000-hp pumps, the loads would be in excess of what the current system could handle without an upgrade in capacity. This is consistent with what had been discovered for Lower Monumental for a similar proposal.

Rolf also noted that our contacts with HDC suggest that the station service system at Goose and Granite are going to be going through a reliability upgrade which is apparently not going to affect capacity.

3. We then talked about the proposed pump test at Lower Granite to confirm the reliability of Fish Pump No. 1. Dave Hurson noted that NMFS is apparently not opposed to the proposed test. It should take about two hours to change out the bulkheads. The pump should be scheduled for the test. There was discussion about the long-term plan for the pump. Dave was of the opinion that perhaps we should take the Philadelphia speed reducer off and replace it with the Falk unit. Dave was of the understanding/opinion that the Falk was a more substantial unit and would be better for the long term if Fish Pump No. 1 became a regular part of the operations at the dam (was worked into a rotation with the other two pumps). Dave felt that the reason the Falk had not been installed was a lack of money to do it since the cover plates would have to be changed out. It was suggested that perhaps it would be better to leave the Philadelphia on so that if one of the other two gear boxes went out (also Falks), then the change-out of cover plates would not be necessary. This might be more efficient. Jerry did not feel that there was any compelling reason to take the Philadelphia box out. It does not seem to have any inherent problems to affect reliability (except the anti-backspin device, which needs to be fixed). It was decided that the report would only suggest that the final configuration of the speed reducers should be left to the projects since they would have the best knowledge about the efficiency of either option.

4. We decided that the ITR review comments would be left off the discussion for today except that Ron felt there were good comments in them.

5. We then talked about the NMFS comments to the report (60%). Rolf noted that there are some rather significant comments regarding the basic question of adequacy of the existing operations at the projects with regards to flow in the attraction water system (see attached comments form NMFS with responses). Rolf expressed concern that these questions really went beyond the issue of providing emergency auxiliary water supply (EAWS) which is the focus of the report. Sean agreed and it was suggested that this was an issue that really needed to be dealt with by the Corps through discussions with NMFS. It was concluded that for the purpose of this report, we should accept the existing AWS operations at the project as adequate and concentrate on EAWS. Other NMFS comments are addressed in the attached response form.

6. Van DeWitt had no specific comments on the report at this time but would provide written comment to Ron. (Editor's note: Van's comments were received on July 25 and will be addressed separately later). It was noted that there is some misunderstanding of the issues related to the recent electrical failure at Goose and that the discussion at the top of page 4-8 is not accurate. Ray said that the failure was a plant-wide blackout. The report text will be corrected to reflect the actual situation.

Dave Absher said that he would like to have the electronic file for the station service protective relay study. He noted that he had spoken with Chris Gantenbein at HDC Portland concerning the availability of the files. It was suggested that we forward that request to Ron and Ron would get in touch with HDC.

7. Dave Hurson noted that the dates on the Page 4-5 are substantially wrong with regards to the repairs of the pumping equipment at Little Goose. The corrected dates were recorded and will be corrected in the report. Jerry noted that his dates came from interviews with project personnel and from the maintenance records and acknowledged that there may be accuracy problems with his sources for this information.

8. Jon Lomeland had not formalized his structural questions at the meeting but offered several for discussion. (Editor's note: Jon's questions were received on July 25 and are attached to these minutes. His comments appearing in the written form will not be repeated in this text. See attached responses.) Jon asked how many pieces the pump station structure would come in prior to assembly. Rolf said that in the text it is suggested that it might be one piece but that one of the ITR comments questioned the feasibility of that considering the variability of the concrete on the dam. Consequently, the structure could come in large subassemblies and assembled into the final configuration underwater.

9. Dave Hurson asked about predators hanging around the open area of the pump station noting that this would be prime predator habitat. Rolf noted that the open design shown could easily be converted to a closed design by adding stiffened panels to the face of the structure if necessary. The text will reflect this concern and ways to deal with it should that be necessary. Dave also asked about the floating orifices on the face of the

powerhouse. Rolf said that any floating orifices in front of Unit 2 would have to be closed in this design. The text will reflect this.

10. Rolf asked Ron if Sverdrup could get information on what the value of lost power generation capacity is at Little Goose (as would be the case for Alternative 1) as well as the cost that the COE uses to assess the cost of electricity for running pumps off the station service system (as would be the case for Alternative 2). Ron asked that a request be sent to him for that information.

11. We then talked extensively about the NMFS comment regarding the butterfly valve shown for Alternative 1. Specifically, the comment was:

"The proposed butterfly valve-diffuser manifold system could be made to work very well at or near the design flow rate. The design would not be appropriate if we wanted to run for extended periods of time at reduced flow rates. The sleeve valve would provide the flexibility to be able to run at any desired rate at or below the design rate."

It was noted that the concept of using the EAWS as a flow supplementation feature in the future was probably inevitable. Dave Hurson said that if the COE builds additional flow capability, that someone will ask that it be used to supplement the existing AWS system. In Alternative 1, this would be accomplished by making the control valve more flexible, i.e., using a sleeve valve that would allow for greater regulation of flow. For Alternative 2, the pump station alternative, one or more of the 212 cfs pumps could be run to add more flow to the system. There is value of course in designing in this flexibility, although strictly speaking, it is not a criteria in developing an EAWS which presumably replaces, on an emergency basis, existing discharge capacity. Sverdrup will review the butterfly valve design and look at options for increased flexibility.

12. After lunch, Ray Eakin contributed a few comments. He suggested another pumping alternative that he had in mind. This one would pump directly out of the existing pump intakes (through the 7-foot thick roof of the pump intake), and into the conduit feeding Diffusers No. 1 and 2 on the South bank. Either this flow would be directed solely to these diffusers, or could be added to the conduit and might also back flow up into the existing pump discharge chamber. The flow requirements of the two diffusers would dictate the feasibility of this concept. Sverdrup will investigate this and add it if it appears to be feasible.

13. Sean Milligan had a few comments. Note that at this writing, his formal comments have not been received. These will be responded to when they are received.

Page 4-11: Sean's first comment was with regard to why 850 cfs was selected for the "spare pump capacity" for Little Goose. Rolf explained that this was because the rated capacity of the Goose pumps was 850 cfs and that it did not make sense to develop spare capacity for a lesser amount, especially if the pumps or the fishway system, which discharges less than this amount in actual operation, might eventually be modified in a manner which will allow them to once again (or for the first time) discharge the rated capacity. Sean agreed with this approach.

Page 2-7 and 4-12: Sean asked why NMFS juvenile fish screening criteria were being applied to the project. Rolf noted that traveling screens were being shown for the forebay intake for Alternative 1 because of the need to preclude entrainment of fish in the supply system. We talked about whether, if the intake was deep enough, screens would be required. Rolf said that the decision to add screens was based on the regional bias towards screening intakes. He also noted that for the Phase II report for Lower Monumental for a similar forebay intake, juvenile screens were included. Sean asked that the report note that the decision to include screens may be related to the depth of the intake and that this should be reviewed during final design.

Page 4-14: Sean was confused about the depiction of the screen extending from El. 646.5 to El. 646.5. Perry explained that the screen actually wraps around from water surface to water surface but acknowledged that the this was confusing. The report will be revised.

Page 4-22: Sean expressed confusion over the apparent contradiction in the discussion of the depth of the tailrace pump station and the need for screens and then shortly following, a discussion that seemed to contradict that for the new pump station. Rolf explained that one discussion was for the Phase I report design for the pump station while the second one was for the Phase II report design for the pump station. Rolf was urged to make the Phase I report discussions more separate from the Phase II report discussions to reduce confusion. This will be done.

14. We talked more about Alternative 2 (the pumped tailrace intake). It was noted by COE staff that the Sverdrup plan to control flow into Diffuser No. 12 would be difficult now that the two gates had been removed. It was suggested that these would need to be replaced to make Alternative 2 work, however, the gate openings should be enlarged to maybe 4'x4' to reduce head losses. The original two gates were 3' wide x 4' and were removed to reduce head losses to Diffuser No. 12.

15. Sean also asked about the plan to route flow back up the Northshore Fishway Supply Conduit and into the pump discharge chamber. He asked if we had considered the hydraulic anomalies that may be caused by flow going in opposite directions in the pump chamber. Perry said that yes, we had, and that with the moderate velocities in these conduits and with the overall turbulence already inherent in the chamber, that this should not be an issue. We will note this in the text.

16. It was asked if the pump station in Alternative 2 could be operated with the draft tube bulkheads installed. Rolf said the he was quite certain that it could (the ability to use the removable seal at the gate slot opening when the bulkheads are in place is the issue here), but he would confirm this and describe this in the text.

17. We talked briefly about Alternative 3 and the construction of this alternative. It was our collective opinion that this alternative has major feasibility issues because of the extensive construction duration to replace each pump. Certainly, this could not be accomplished during the normal maintenance window in January and February. Consequently, construction would have to stretch into the normal ladder operation season. This would mean that at least one of the existing pumps would not be available meaning that the AWS would be operating on only 2 of the 3 pumps. This would not be acceptable unless a replacement water source could be added or the fishway operated significantly below FPP criteria for an extended period of time. This issue will be noted in the report text.

18. Rolf asked Ron which year dollars the cost estimates should be prepared for. Ron asked that they reflect costs in October, 2000.

19 The meeting ended at 2:10 PM after which time, the Sverdrup team reviewed the map files for drawings for Ray's new alternative. We also talked with other COE staff members. We departed for the airport at about 4:00 PM for our return flight to Seattle.

Prepared By: Rolf G. Wielick
Rolf G. Wielick

Distributions:
Meeting Attendees
Project Files

Review Comments

Project: Aux Water Supp. 60%

Location: L.Gran & L. Goose

Date: 25 Jul-00 **Reviewer:** Jon Lomeland **Telephone:** 509-527-7652

XX NWW-EN-DB-ST
__ Air Force
__ Army

Design Document
__ D. Memo
__ P&S
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__ Concept
__ Prlim.
__ Final

Discipline
__ Arch.
__ Civ.
__ Mech/Elect.
_X_ Struct.

Action taken on Comments by: R. Wielick, G. Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
1.	Page 4-6	Second paragraph statement talks about the motors overheating because of the high oil viscosity. I think this paragraph may have been mixed up with Lower Granite because there are hydraulic turbines at Little Goose not motors.	**A** - Yes, this will be fixed.		
2.	Page 4-6	The third paragraph says the original equipment was installed in 1972. The table at the bottom of the page says the speed reducers had major failures in 1970, which is before the equipment was installed according to the previous paragraph.	**A** - This will be corrected in the text. Original equipment was installed in 1970.		
3.	Page 4-17	Paragraph b. The flow control for the gravity flow system is controlled by the butterfly valve. Is there a potential problem in the pump discharge chamber if the butterfly valve were to accidentally get opened up to far? Could the discharge chamber be subjected to excessive pressures or loads from the forbay water pressure.	**A** - The way to prevent this from happening would be to limit the extent that the valve could be opened with limit switches. The text will be updated to reflect this concern.		
4.	Plate 1.2.2	1.It looks like it may be difficult to get the draft tube bulkheads in the slots behind the pumps. Is their adequate clearance? 2. How does the steel plug in the bulkhead slot get removed if a bulkhead needs to be installed? 3. How is the steel structure protected from corrosion?	**A** - The design is intended to provide a clear path for bulkheads, roughly defined by the width of the slot opening in the concrete roof of the draft tube discharge. This should be possible with the configuration shown. Note that the flap gate which appears to protrude into this space would not protrude during the installation/removal of the bulkheads. The same mechanism/system that is used to retrieve the bulkheads (lifting beam on the crane and lifting eyes on the equipment) would be used. Should work the same way. Corrosion protection could be the COE's heavy duty paint system or a metalized coating system. Impressed current systems don't seem to be very successful over the long term.		

Review Comments Project: Aux Water Supp. 60% **Location: L.Gran & L. Goose**

Date: 25 Jul-00 Reviewer: Jon Lomeland Telephone: 509-527-7652					**Page 2 of 2**
XX NWW-EN-DB-ST __ Air Force __ Army		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. __ __ Final **Discipline** __ Arch. __ Civ. __ Mech/Elect. _X_ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: R. Wielick, G. Walker		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

NWW-EN-DB-ME
__ Air Force
__ Army

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Design Document		**Discipline**	
__ D. Memo	__ Concept	__ Arch.	
__ P&S	__ Prlim.	__ Civ.	
__ 50%	__ Final	__ Mech./Elect.	
		__ Tech	__ Struct.

REVIEW CONFERENCE — A-comment accepted; W-comment withdrawn (if neither, explain)

DESIGN OFFICE — C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: R. Wielick, P. Johnson, G. Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
1	General	The discussions of the mechanical condition of the equipment are very thorough. Most of the conclusions and recommendations are supported by complete and logical discussions of the relevant background information. The proposed alternatives appear to be practical and well thought out. However, as discussed below, there needs to be further investigation as to whether or not we have adequate capacity at Little Goose, and spare capacity at Lower Granite.	**A** – Thanks!		
2	2.3.1	Page 2.5, 1st paragraph. *Changes in pump (or water supply) configuration should be accomplished in 24 hours. This would include rotating a spare "emergency" AWS pump into operation and a failed pump out of operation . . . .* One of the beneficial features of the proposed emergency systems is that they do not require a long lead time to prepare for operation. The proposed alternatives can be activated by starting motors and opening valves. It seems the emergency system could be activated in less than 4 hours - allow about 2 hours to troubleshoot the casualty in the main system and determine if it can be re-started, and about 2 hours to do any required pre-start checks on the emergency equipment.	**A** – The text in the report says …" *should be accomplished in less than 24 hours…"* This is a reasonable goal and accounts for the fact that system failures can occur on Saturday evening at 10:00 pm when it takes 2 hours for anyone to appear at the dam to deal with the problem. It is our understanding from project staff that a pump bulkhead change can take up to 7 hours on the weekend.		
3	Misc.	3.1 Design Page 3-1, 1st Paragraph *Likewise, detailed hydraulic calculations . . . has [sic] not been performed.* 4.2.2.1 Hydraulic and Fish Passage Evaluation Page 4-3, 4th paragraph *There is considerable uncertainty about actual flow rates supplied by the pumps.*	**A** – These statements correctly characterize the level of uncertainty that currently exists with regards to the status of the existing pumping equipment discharge capabilities. It has been our position (concurred with by the COE), that the current operations of the projects with regards to the AWS is the		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 Reviewer: National Marine Fisheries Service Telephone:			Page 2 of 11	
NWW-EN-DB-ME __ Air Force __ Army 60%Comments_NMFS.DOC		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. __ 50% __ Final **Discipline** __ Arch. __ Civ. __ Mech./Elect. __ Tech __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: R. Wielick, P. Johnson, G. Walker		
		Page 4-4, 3rd paragraph *It appears that flow rates equal to the combined capacity of the three turbine-pump units must be supplied to the auxiliary water system to be in* ***near*** *[emphasis added] compliance with the criteria.* 4.2.2.2 Mechanical Evaluation Page 4-5, 4th paragraph *The study did find that with regards to total pump output, current fish passage criteria was [sic] being met.* 4.2.3 Evaluation Summary Page 4-8, last paragraph *All three pumps are required to meet FPP criteria, although conformance to the criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and at various locations in the fishway channel due to velocities below the 1.5 fps minimum transport velocity.* Page 4-9, 4th paragraph *Since the existing auxiliary water system at Little Goose currently has no spare capacity . . . .* 4.6.3.2 Hydraulics Page 4-34, 1st paragraph	baseline condition by which to evaluate the EAWS requirements. We have duly noted in the report that FPP criteria are not satisfied during all operating conditions and that this is an issue that needs to be resolved. However, with regards to EAWS, it is our finding that relative to the current operations at the projects (whether they fully meet the FPP or not), there is no spare capacity at Little Goose since all three pumps are utilized to achieve current levels of flow, and that at Lower Granite, there is one pump that is not used and therefore, there is one pump spare capacity at that project. As you note, there is a need to identify the conditions where criteria is not being met and decide whether to design-in the capacity to meet criteria at those times. It is our opinion that this report, as currently scoped, is not the forum for that investigation.		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 Reviewer: National Marine Fisheries Service Telephone:			
NWW-EN-DB-ME __ Air Force __ Army 60%Comments_NMFS.DOC **Design Document**: __ D. Memo, __ P&S, __ 50%, __ Concept, __ Prlim., __ Final **Discipline**: __ Arch., __ Civ., __ Mech./Elect., __ Tech, __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: R. Wielick, P. Johnson, G. Walker		
		Despite this, there is substantial uncertainty about current pump discharge capacity. Indications are that current flow rates lie somewhere between 2,100 and 2,550 cfs. As a consequence, there is uncertainty regarding what discharge needs to be supplied by the upgraded pumps . . . A comprehensive field rating of the existing system should be considered prior to selecting a preferred option. 5.2.3 Evaluation Summary Page 5-9, 3rd paragraph *Based on the operational history at Lower Granite, only two of the existing three pumps are required to meet FPP criteria, although conformance to the criteria is marginal (but apparently acceptable) at the North Shore ladder entrances due to sub-criteria head differentials and at various locations in the fishway channel due to velocities below the 1.5 fps minimum transport velocity.* The above excerpts expose a few weak spots in the assumptions and analyses of the present and proposed AWS systems (leaving aside, for the moment, the problem of insufficient weir submergence during low tailwater elevations): a) We do not know accurately the output of the AWS pump stations throughout the range of tailwater elevations - with 1, 2, and 3 pumps operating. b) We need to abandon the notion that "marginal conformance" to the criteria is an acceptable operating condition or design point. We need to determine explicitly which criteria cannot be achieved - at each entrance and collection channel reach- throughout the normal range of tailrace elevations and pump combinations - Little Goose and Lower Granite. c) We cannot conclude whether or not the present pumps at Little Goose			

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 Reviewer: National Marine Fisheries Service Telephone:					Page 4 of 11		
NWW-EN-DB-ME __ Air Force __ Army 60%Comments_NMFS.DOC		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. __ 50% __ Final **Discipline** __ Arch. __ Civ. __ Mech./Elect. __ Tech __ Struct.		**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(If not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**		Action taken on Comments by: R. Wielick, P. Johnson, G. Walker		
		have excess capacity, or that two pumps at Lower Granite are sufficient, until step (b), above, has been completed. There are conditions when we do not meet criteria even with 3 pumps at Little Goose and 2 pumps at Lower Granite. We need to identify those conditions and decide whether to design-in the capacity to meet criteria at those times. d) No allowance was included for any spare pumping capacity. The Corps already has sufficient historical data to begin this evaluation. Lisa Hetherman has *daily* records (archived on an annual basis) of the weir submergences and collection channel-tailrace (C-T) differentials for all ladder entrances, and tailrace water surface elevations, and pump discharge chamber water surface elevations for all the lower Snake River projects. The data show all the main hydraulic conditions when the projects do and do not meet ladder entrance criteria.				

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

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__ Civ.
__ Mech./Elect.
__ Tech __ Struct.

Action taken on Comments by: R. Wielick, P. Johnson, G. Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
4	4.2.2.2	Page 4-5, 2nd paragraph *If one of the pump units shuts down, automatic controls reduce the wicket gate openings of the remaining turbines to 60%. This is to prevent overspeed due to the increased head . . . .* Page 4-6, 3rd paragraph *Turbine wicket gates usually develop a "set" after remaining in one positions for a period of time. The plant operators have to bump the gate shaft operator back and forth for some time before the wicket gates will move. This process can take several hours.* Suppose one of the pump units shuts down. Do the automatic controls have to "bump the gateshaft operator back and forth . . . for several hours" to adjust the wicket gates?	**A** – The plant has recently instituted a program of cycling the wicket gates twice a week. This has solved the sticking problem except for turbine 3 which can only move about 10% gate. The plant will free up turbine 3 after the fish passage season. The report will be revised to describe this recent change. When a pump goes offline due to a problem, the turbine is stopped by automatic closing the inlet butterfly valve. Plant personnel then have to manually "bump" the wicket gates to close them. But without the turbine running. The report will be revised to indicate this information.		
5	Page 4-6	Table at bottom of page 4-6 Are all of these speed reducers, including the replacements and spares, manufactured by Philadelphia Gear? Is the spare gear stored at Little Goose an original speed reducer, or an upgraded/rebuilt one?	**A** – All LGO speed reducers are Philadelphia units. The spare speed reducer is an upgraded/rebuilt unit.		
6	4.2.2.3	Page 4-8, 1st paragraph *If a failure occurs in the AC supply, the [wicket] gate operators should automatically be able to derive their power from the DC supply. The DC power for the gate operators is derived from station batteries. There are apparently*	**A** – The issues and conditions related to this are being clarified by Ray Eakin at Little Goose. The text will be updated to reflect this change.		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

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REVIEW CONFERENCE — **A-comment accepted, W-comment withdrawn (if neither, explain)**

DESIGN OFFICE — **C-correction made (if not, explain)**

Back Check By: (Initials)

Action taken on Comments by: R. Wielick, P. Johnson, G. Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
		problems with the transfer from AC to DC power. During start-up of the pumps for the 2000 fishway operating season, this system failed causing a temporary failure of the fishway auxiliary water system (Larry Swenson, NMFS, March 2000). There are several questions here: a) The above section requires more investigation and explanation. Is the switch-over to DC power intended to continue operating the wicket gates, or is it intended to only close the gates (i.e., shut down the turbines) until AC power is restored? b) If the AC to DC switch-over doesn't work, and the gates have to be "bumped" for a long time before they will move, it sounds like automatic shutdown capability of the wicket gates - at least due to loss of AC power - is basically inoperable. What about automatic shut down due to loss of lube oil pressure or high temperatures? Do those systems work? c) The failure in March referenced in the discussion with Larry Swenson was a dam-wide electrical outage, not just a localized loss of AC power to the AWS systems. Our understanding is that the lube oil pumps are driven by AC motors, and that during the March outage, the lube oil pumps stopped, and that the wicket gates were closed automatically - and successfully. For other than dam-wide electrical outages - do we have redundant AC feed to the auxiliary equipment that support the AWS pumps?			
7	4.4.3.2.c	Pages 4-14 and 4-15 The proposed butterfly valve-diffuser manifold system could be made to work very well at or near the design flow rate. The design would not be appropriate if we wanted to run for extended periods of time at reduced flow rates. The sleeve valve would provide the flexibility to be able to run at any desired rate at	**A** – This is true. However, as an EAWS enhancement, the operations scenario we are designing for would require only a full on or full off operation. If the system were		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

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__ Tech __ Struct.

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (initials)
		Action taken on Comments by: R. Wielick, P. Johnson, G. Walker			
		or below the design rate.	used for something other that EAWS, for example, to supplement the flow in the existing AWS, a sleeve valve would be a better options. Based on discussions with vendors of sleeve valves, the cost differential between the butterfly valve and the sleeve valve is approximately $220,000. In discussions with the COE on this issue, it was noted that greater flexibility with regards to future use of the system would be gained if the system could accommodate a greater range of flows. It seems prudent to anticipate this very likely scenario and design the system in that manner. Consequently, the report will be revised to show the sleeve valve, but describe the butterfly valve as a potential flow control device.		
8	4.5.3.2.b	Page 4-25, 4th and 5th paragraphs *With the proposed design, the pumps discharge horizontally into the chamber. A full velocity head loss occurs at this location.* *Pump chamber head loss, head losses in the fishwater supply conduit, and the*	A – The 7.2 feet is Total Dynamic Head while the 4 feet is the pumping head. This will be clarified in the text. Because of the limited number		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

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Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain) Action taken on Comments by: R. Wielick, P. Johnson, G. Walker	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (initials)
		requirements for a 4.0 ft differential for supplied water (above tailwater) were summed to determine required total pump lift of approximately 7.2 feet. How does the total lift of 7.2 feet compare with that of the present pumps? Will not the proposed 12 ft by 8 ft openings in the side of the water supply conduit create additional head loss in the conduit and further reduce the flow of water to the north shore when the emergency pumps are not in use? Will this system work if the draft tube bulkhead gate is deployed? Perhaps the pump chamber head loss could be significantly reduced by replacing the proposed vertically oriented pump with a horizontally oriented pump. The centerline of the pump could be at elevation 494.75, directly across from the opening in the side of the water supply conduit. The driver for the pump could be a hydraulic motor. A conduit could connect the discharge of the pump directly to the side of the water supply conduit. This would eliminate the need for the ballasted removable bulkhead slot plug.	and extent of the supply openings, it is anticipated that the openings in the conduit walls will cause negligible additional head losses in the conduit. This will be verified through computation We are confirming that the bulkhead gates do not protrude above the concrete beam. Assuming they don't, yes, the system will operate with the bulkhead gates in. No hard connection (pipe) across the bulkhead slot is possible since this would be an obstruction to the travel of the bulkhead gates and would have to be removed by a diver each time the bulkhead gates were		
9	4.7 ALTER-NATIVE 4	Dave Hurson maintains a backlog list of the significant unfunded maintenance. All work pertaining to the maintenance of existing fishway components, especially if they will be retained after the Emergency AWS system is installed, should be highlighted in an appendix to this report, and should receive added funding priority.	**A** – We will attempt to get this information.		
10	SECTION 5	Page 5-1, 2nd paragraph Should "627" be changed to "727" ?	**A** – We will review this. Something is wrong here!		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer:** National Marine Fisheries Service **Telephone:**

NWW-EN-DB-ME
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Design Document: __ D. Memo __ Concept __ P&S __ Prlim. __ 50% __ Final

Discipline: __ Arch. __ Civ. __ Mech./Elect. __ Tech __ Struct.

REVIEW CONFERENCE — A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE — C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: R. Wielick, P. Johnson, G. Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
11	5.2.2	Bottom of Page 5-3 to top of Page 5-4 *Evaluations conducted . . . indicated that supplied pumped flow rates may be as much as 2% greater than to 19% less than the original project design requirements.* *. . . close correlation between flow rates determined from the manufacturer's rating curves and from analysis of the distributions system imply that the manufacturer's pump rating my be fairly representative.* What does "fairly representative" mean? Is that like "marginal conformance?" What is the message in these paragraphs? Does this mean the pump performance agrees with the pump curves, but the design requirements called for higher performance?	**A** – This will be clarified in the text.		
12	5.2.2	Page 5-4, last paragraph *Simultaneous operation of all three pumps (possibly with one pump operating at half speed) could also be used to increase flow through the fishway system. It is likely that such an operation would increase flow rates at the North Shore Entrance, bringing created differentials into compliance.* Page 5-6, last part of 4th paragraph *It was concluded that simultaneous operation of three pumps is not viable a very low tailwater elevations, but that normal pump operation can be expected for simultaneous operation of any two pumps regardless of tailwater conditions. Another problem with three-pump operation is the limited outflow capacity of the diffuser system, causing a rise in discharge chamber levels, increasing the head on the pumps above four feet.*	**A** – The first citation was not quoted in full. It observed that previous operation with three pumps at low tailwater has led to pump overheating and shutdown. This will be clarified. The two statements are not contradictory.		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 Reviewer: National Marine Fisheries Service Telephone:					
NWW-EN-DB-ME __ Air Force __ Army 60%Comments_NMFS.DOC	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. __ 50% __ Final	**Discipline** __ Arch. __ Civ. __ Mech./Elect. __ Tech __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: R. Wielick, P. Johnson, G. Walker		
		These paragraphs seem contradictory - they cannot both be correct.			
13	5.2.3	Page 5-9, 1st paragraph *Without the on-site spare, procurement of a new unit would require approximately 35 weeks.* Does the 35 weeks include administrative time for preparing drawings, specifications, advertising and awarding?	**A** – The 35 weeks assumes an expedited, sole source procurement from the manufacturer of the affected speed reducer (either Falk or Philadelphia)		
14	5.2.3	Page 5-9, 3rd paragraph *Thus, there is a one-pump spare capacity at the project, meeting the spare capacity requirement list in the assessment criteria* This is not correct. There are many days throughout the fish passage season when the criteria cannot be met (especially at North Shore entrance) with the two pumps.	**A** – Using current operations as a yardstick, and recognizing that FPP criteria are not met under all conditions, it is our assessment that spare capacity exists as it relates to EAWS. Changes in project operations or configuration to increase flow to rectify non-conformance of FPP criteria is not within the scope of this report.		
15	5.4.3.1.a	Page 5-12 - first bullet *The pump should be operated in tandem with either Pump No. 2 or Pump No. 3. There is no perceived need to test all three pumps simultaneously since FPP criteria is [sic] apparently (nominally) satisfied with the operation of only two pumps.* This is not correct, as discussed above. Also, there is a need to: a) determine why all three pumps cannot be run in parallel, and b) determine what if any	**A** – See comment response for Item 14.		

Technical Review Comments

Project: Granite and Goose EAWS 60% Report **Location:** Granite/Goose Dams

Date: 7/12/00 **Reviewer: National Marine Fisheries Service** **Telephone:**

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Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
			Action taken on Comments by: R. Wielick, P. Johnson, G. Walker		
		hydraulic benefit there may be for running three pumps, and c) re-assess if we need to add spare pumping capacity.			
16		What is the condition of the Formsprag anti-backspin devices in Pump Nos. 2 and 3? They run all the time, so perhaps we don't know if their anti-backspin devices work. For example: if we run Pump Nos. 1 and 3, as suggested in the report - will No. 2 spin backwards?	**A** – As note in the fifth paragraph of 5.2.2.2 (pp 5-5), the Falk gearboxes on Pumps 1 and 2 incorporate internal anti-backspin devices, while the Philadelphia gearbox on Pump 1 has an external device of the Formsprag type. We believe Philadelphia could not provide a suitable internal device. Plant records do not show problems with the Falk anti-backspin devices.		

Review Comments

Project: Gr/Goose EAWS-Phase II Tech Rep 60% Location: Granite/Goose

Date: 25-Jul-00 **Reviewer:** Ron Porter **Telephone:** 509-527-7519

XX NWW-ED __ Air Force __ Army	**Design Document** __ D. Memo __ P&S X 60% Tech Report	**Discipline** __ Concept __ Arch. __ Prlim. _X_ Civ. __ Final __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
1.	Page 4-4	Bullet that starts Differentials, should have "Head" added	**A** - The text will be revised.		
2	Pgs 4-4 & 4-5	Paragraphs that discuss compliance with criteria need to be clear on exactly what is being met. (They seem to indicate that criteria is being met.)	**A** - The text will be reviewed and revised to clarify.		
3	Pg 4-5	Paragraph at the bottom of the page, " Except as noted …" should this sentence perhaps follow Pump #1 description.	**A** - The text will be revised.		
4	Pg 4-6	Paragraph should read service life not lives.	**A** - The text will be revised.		
5	Pgs 4-7,34	Fix references to Lower Moument to Lower Monumental	**A** - The text will be corrected.		
6	Pg 4-9	Sentence at top of page, revise to "spare capacity is not being met..".	**A** - The text will be corrected.		
7	Pg 5-8	First para. should read "Both firms maintain …".	**A** - The text will be corrected.		
8	General	Didn't see an indication (ToC) of the proposed schedule to complete design & construction – see SOW para 2.3.	**A** - This was omitted. The document will have design and construction schedules for the recommended alternatives for each project per the SOW.		
9	General	Maintenance items (spare parts to be procured etc.) should be identified that are recommended for future procurement with an estimated cost, quantity, and by project. Perhaps this should be listed in a separate Appendix – SOW para 8.1.	**A** - The report will include these.		
10	General	Some Alts. may need more explanation on the proposed steps for constructing each option.	**A** - The alternatives will be reviewed to ensure that the construction sequences are described sufficiently to convey the concept.		

Review Comments Project: **Emerg. Aux. Water Supply** **Location: Goose/Granite**

XX NPW-EN-DB-HY __ Air Force __ Army		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. _xx 60% P2 __ Final **Discipline** __ Arch. **XX** Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date: July 28, 2000		**Reviewer: Sean Milligan** **Telephone: (509) 527-7535**			**Page 1 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
		Content Comments			
1.	4.4.1	1st bullet: The conclusion in the system analysis was that the pumps don't actually produce 850 cfs, so the argument could be made that "one-pump equivalent" is actually something less than 850 cfs, maybe closer to the 700 cfs used in the Phase 1 report. My opinion is that the 850 cfs is a better number, but maybe need to make the case somewhere why we are using that value for the "one-pump equivalent".	**A**- In truth, the Phase I report assumes a total EAWS capacity of 850 cfs but makes use of the additional 180 cfs from the juvenile facilities to justify designing pumping or gravity systems for only 700 (700 + 180 ~ 850). We concluded in Section 4.4.1, first bullet, that this was not an appropriate methodology given the fact that the juvenile facilities do not operate from December 16 to March 30 leaving a window of time (as much as 3 months if the ladders do not need to go down) when the additional flow is not available. Hence the decision to design for the full 850 (which is the rated capacity). As to why choose 850 rather than 700, we will include a justification in the text. This is basically because we feel that the reduced performance of the pumps is not a condition that is long term given the state of flux that the whole AWS system is in (is there enough water for fish guidance or is there not?). It may be that we will figure out a way to reduce losses or improve performance or reduce leakage so that the pumps will achieve the rated capacity. Designing the EAWS to match a system condition that is not considered to be optimal seems a poor long-term strategy.		

Review Comments

Project: Emerg. Aux. Water Supply **Location: Goose/Granite**

XX NPW-EN-DB-HY
__ Air Force
__ Army

Design Document: __ D. Memo; __ P&S; _xx 60% P2; __ Concept; __ Prlim.; __ Final

Discipline: __ Arch.; XX Civ./Hydr.; __ Mech/Elect.; __ Struct.

REVIEW CONFERENCE: A-comment accepted; W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Date: July 28, 2000 **Reviewer: Sean Milligan** **Telephone: (509) 527-7535**

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick		
2.	4.4.1	2nd bullet: I agree that for the configuration shown in the Phase 1 report a juv. fish screen may be required, but may want to indicate that whether a fish screen is required or not is somewhat dependent on how deep the intake is.	**A**- We will add discussion in the text noting that an evaluation of intake depth may result in a waiver for screens, however, our experience is that the agencies will not allow this. It should be noted that similar withdrawals shown in the Phase II report for LoMo showed extensive screening for juvenile fish.		
3.	p. 4-14	2nd para: The way the baffle placement is described, from elevation 646.5 to elevation 646.5 (same elevation) is confusing if you don't understand it's a U-shape. Maybe add a little more description to make it clearer. Also add units (ft) to the elevations.	**A**- We will clarify the text.		
4.	p. 4-15	2nd para: The gravity system may become part of the primary water supply rather than just emergency backup to reduce wear and tear (and thus maintenance) on one of the pumps. The flexibility of variable discharge is also an attraction to using this as part of the primary water supply. So it may not be valid to assume only short-term, intermittent use.	**A**- We are changing the design to include a sleeve valve. This will add more flexibility. I don't think, however, that we want to add the ability to supplement flow to the existing system as a design criteria, however, since the implications would include such things as the impact of increased water surface elevations in the fishway and a consequential diminishing performance of the pumps, or discharge from a supplemental flow system. Also, then you raise the bar on what an EAWS design flow should be. More than 850 cfs?		
5.	p. 4-22	Last bullet in 4.5.1 & 3rd bullet in 4.5.2: It's sort of confusing to have seemingly contradictory statements so close together about whether juv. fish screens are required if you don't notice one is referring to the Phase I work and the other is the new Phase II criteria. Suggest putting the Phase I Tech. Rpt Alternative Review section back under Section 4.3 to keep all the Phase I stuff together. Applies for all the alternatives.	**A**- We'll change the report to make it less confusing. Thanks for the good suggestion. Sometimes you know the report so well, you read right through these types of things.		

Review Comments Project: **Emerg. Aux. Water Supply** **Location:** **Goose/Granite**

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. _xx 60% P2 __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Date: July 28, 2000	**Reviewer: Sean Milligan**	**Telephone: (509) 527-7535**			**Page 3 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
6.	4.5.3.2.b	Will the additional flow (575 cfs) flowing back into the pump discharge chamber through the conduit make significant changes in the hydraulics in the chamber? I'm just concerned that this conduit is right next to one of the other outlet conduits and currently a smaller volume of water flows out this conduit, not a larger volume flowing back in. Maybe add some discussion of what you think the effects might be and whether this is significant to the overall performance of the system.	**A**- We will address this concern in the report text. As Perry noted in the meeting, he considered this in his assessment of the viabilty of the alternative. We just didn't write it down.		
7.	4.5.3.2.b	What happens if the draft tube bulkheads are installed? I think you can still operate since the bulkhead would be below the plug, but you need to spell out the necessary procedure, indicating that there would be a short (xx hrs) interruption in service while the bulkhead is being set.	**A**- Yes you can. Plenty of clearance per the drawings. We will cover this and the procedure in the text.		
8.	4.5.3.2.c	Need to confirm that the conduit sizing is sufficient for the 850 cfs since it only carries about 275 cfs at present. I'm sure you've done these calcs; it should just be noted in the text.	**A**- We will cover this in the calculations.		
9.	4.5.3.2.c	According to Ray Eakin, the gates are gone from Diff. 12. They will have to be replaced to provide the necessary control.	**A**- Yes. We will address this in the report.		

Review

Comments Project: **Emerg. Aux. Water Supply** **Location:** **Goose/Granite**

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. _xx 60% P2 __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)

Date: July 28, 2000 **Reviewer: Sean Milligan** **Telephone: (509) 527-7535**

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick		
10.	4.5.3.3	1st para: Again, we may not be able to count on infrequent usage as emergency backup only. This may become part of the primary water supply, especially with the flexibility afforded by variable discharge depending on how many pumps are on. Thus, efforts should be made to make maintenance as simple and easy to accomplish as possible.	**A**- Yes. We will review the maintenance aspects of these alternatives in the context of longer-term use. As noted in the response to your comment No. 4, introducing the use of these "emergency" systems for "long-term" use is a slippery slope in terms of design. Some systems are designed truly as "emergency" systems (such as emergency generators, etc.) which are viable for emergency use but become impractical for longer-term use. I don't think we have any severe issues like this in the alternatives we've proposed. In an evaluation matrix, the appropriateness of one or the other alternative for long-term use could be an evaluation criteria. The weight of this criteria is the question.		
11.	4.5.3.3.a	2nd para: Based on LoMo discussions, it is very unlikely that either submersible in-line pumps or hydraulic pumps would be selected. The project people have strong objections to these types of pumps.	**A**- Thanks for the information. Final selection of pump types would eventually be a final design issue. Several types could be proposed. Minor configurational changes would occur, but the concept remains valid.		
12.	4.6.3.1	Can the work necessary for this alternative be done in one fish window? I doubt it could, which kills this alternative in the starting blocks. It may be possible to do just one pump a year or something, but I think that would add a lot of cost (multiple mob/demob, add'l work to isolate work area, etc.) and wouldn't be real desirable to have this drag on over several years anyway.	**A**- Personally, I think it pretty much kills it, too. We will note in the text that this issue exists and attempt to propose work-around plans to make it more reasonable, if that's possible. The other problem with taking one pump down is that now you are way out of criteria for the AWS system. I can't imagine how the agencies would approve this type of disruption to the attraction water.		

Review Comments

Project: Emerg. Aux. Water Supply **Location: Goose/Granite**

XX NPW-EN-DB-HY
__ Air Force
__ Army

Design Document: __ D. Memo __ P&S _xx_ 60% P2 __ Concept __ Prlim. __ Final

Discipline: __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Date: July 28, 2000 **Reviewer: Sean Milligan** **Telephone: (509) 527-7535**

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
		Editorial Comments			
1.	2.3.4	"criteria" is plural; phrase should read "…structural criteria are presented…"	A- Yes, text will be revised.		
2.	4.1	"lower" is not capitalized in "lower Snake River"	A- Yes, text will be revised.		
3.	4.1	Show units of ft or fmsl after elevations	A- Yes, text will be revised.		
4.	4.2.2.1	2nd Para, 3rd sentence: turbine-pump manufacturer (add "r")	A- Yes, text will be revised.		
5.	4.2.2.1	"shortfall" should be one word	A- Yes, text will be revised.		
6.	4.2.2.1	3rd bullet in 2nd group: add space between "may" & "be"	A- Yes, text will be revised.		
7.	4.2.2.2	Last full para on p. 4-5: "…criteria were being met."	A- Yes, text will be revised.		
8.	p. 4-7	2nd para: add "al" to "Monumental"	A- Yes, text will be revised.		
9.	p. 4-8	2nd para: "…it is essential…" (add "it")	A- Yes, text will be revised.		
10.	4.4.2	1st sentence: delete the "the" before "this"	A- Yes, text will be revised.		
11.	p. 4-14	2nd para: "An internal …" ("an", not "a")	A- Yes, text will be revised.		
12.	p. 4-17	2nd para: add units to elevations (ft or fmsl)	A- Yes, text will be revised.		
13.	p. 4-18	1st para: "…emerges from the downstream…" (add "the")	A- Yes, text will be revised.		
14.	4.4.3.5	1st para: fill in or eliminate the blank	A- Yes, text will be revised.		
15.	4.5.2	Last bullet: This is an incomplete sentence. All the other bullets are complete sentences, so this one should be too for consistency.	A- Yes, text will be revised.		
16.	4.5.3.1	"Northshore" should be two words.	A- Yes, text will be revised.		
17.	4.5.3.3.a	"gpm" is not capitalized	A- Yes, text will be revised.		
18.	4.5.3.3.a	2nd para: "…driven by an electrically …" ("an" not "a")	A- Yes, text will be revised.		
19.	4.5.3.4.b	2nd para: add units to elevations (ft or fmsl)	A- Yes, text will be revised.		
20.	4.5.3.4.b	3rd para, last sentence: "…has not been performed…" ("been", not "be")	A- Yes, text will be revised.		
21.	4.6.1	2nd para, last sentence: add "ed" to "detailed"	A- Yes, text will be revised.		
22.	4.6.2	3rd bullet: change decimal to comma in 2,550 cfs	A- Yes, text will be revised.		
23.	4.6.3.3.d	Underline heading.	A- Yes, text will be revised.		
24.	4.6.3.4.a	"powerhouse" should be one word. Also, why is there a subsection "a" if there are no further subsections?	A- Yes, text will be revised. We'll take the "a" out.		
25.	4.7.2 & 5.4.2	"following criteria were used…"	A- Yes, text will be revised.		
26.	5.2.1.1	1st para: "627" should be "727"	A- Yes, text will be revised.		

Review Comments

Project: Emerg. Aux. Water Supply **Location: Goose/Granite**

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. _xx 60% P2 __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Date: July 28, 2000	**Reviewer: Sean Milligan**	**Telephone: (509) 527-7535**		**Page 6 of 6**	

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick		

Review Comments

Project: Gr/Goose EAWS-Phase II Tech Rep 60% **Location:** Granite/Goose

Date: 25 Jul-00 **Reviewer:** Van D. DeWitt **Telephone:** 509-527-7562

XX NPW-EN-DB-EL
__ Air Force
__ Army

Design Document
__ D. Memo
__ P&S
60% Tech Report

__ Concept
__ Prlim.
__ Final

Discipline
__ Arch.
__ Civ.
XX ~~Mech~~/Elect.
__ Struct.

REVIEW CONFERENCE: A-comment accepted / W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Dave Absher, Gerald Walker

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
1.	5.4.3.2 b.	Concur with comment number 9 from Aaron Newman, technical reviewer, about DC controls. Simply a different set of potential problems. May not actually improve reliability.	**A** - Due to the cost of the change to DC controls, our final recommendation will be to improve the spare parts inventory		
2.	5.4.3.2 a.	Don't see how reliability is improved by adding the transfer switch and the single bus point common to all pumps. If a failure occurs in the transfer switch or anywhere in the single bus between the transfer switch and the pumps, all pumps would be out. This scheme introduces two potential single mode failure situations. The ATS also requires regular maintenance and testing to insure reliability. What spare components are anticipated to prepare for the new potential single mode failures and how long would a replacement take?	**A** - The current system is very susceptible to a common mode failure, in that the only operable pumps are connected to a single bus. A failure of this bus, or any of the downstream power distribution components, would leave the project in violation of minimum flow requirements for a considerable period of time. Automatic transfer switched are used everywhere there is a concern for the reliability of the electrical supply system, such as hospitals and computer centers. Our final recommendation, which is a variation of this scheme, will involve connecting Pumps 2 and 3 permanently to busses 1 and 2, respectively. Then only Pump 1 would be provided with an automatic transfer switch. In this case a failure of one bus would only disable a single pump instead of possibly disabling two. Pump 1 would then transfer to the available bus. Automatic transfer switches of this size are constructed from large, draw-out style circuit breakers. A spare breaker will be kept in stock in case of a failure. The changing of a circuit		

Review Comments

Project: Gr/Goose EAWS-Phase II Tech Rep 60% Location: Granite/Goose

Date: 25 Jul-00	Reviewer: Van D. DeWitt	Telephone: 509-527-7562			
XX NPW-EN-DB-EL __ Air Force __ Army		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. 60% Tech Report __ Final **Discipline** __ Arch. __ Civ. XX ~~Mech~~/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Dave Absher, Gerald Walker		

			breaker would take less than an hour.		
3.	4.5.3.5 b.	In the event that some of the new pumps proposed could be used continuously to increase water (per David Hurson's comments in the meeting of 18 July) the ATS scheme may be vulnerable to the same single mode failures noted in item #2 above.	**A** - Capacity information from HDC was not provided until after the 60% report was issued. This information indicates that the current power distribution system only has enough spare capacity to accommodate two 300 HP motors on each of the station service buses. Therefore the proposed scheme will not make use of an automatic transfer switch.		
4.					

Sverdrup Civil, Inc. Northwestern Region/Seattle

September 22, 2000
X310 01 MM 003

MEETING MINUTES

DATE: September 19, 2000

TIME: 9:30 AM – 11:30 AM

PLACE: USACE Walla Walla District Conference Room - Walla Walla, WA

SUBJECT: USACE Walla Walla District - Contract No. DACW68-99-D-0003
Task Order No. 1 – Little Goose/Lower Granite EAWS
100% Submittal Review Meeting

ATTENDEES:

Name	Company	Phone Number	Location
Ron Porter	USACE - Walla Walla	(509) 527-7519	Walla Walla, WA
Van DeWitt	USACE - Walla Walla	(509) 527-7562	Walla Walla, WA
Sean Milligan	USACE - Walla Walla	(509) 527-7535	Walla Walla, WA
Kevin Renshaw	USACE - Walla Walla	(509) 527-7570	Walla Walla, WA
Karl Pankaskie	USACE - Walla Walla	(509) 527-7517	Walla Walla, WA
Dave Embree	USACE - Walla Walla	(509) 843-1493	Lower Granite Dam
Rolf Wielick	Sverdrup Civil, Inc.	(425) 452-8000	Bellevue, WA

MINUTES:

1. The following is a summary of the discussions and significant issues raised during the 100% submittal review meeting as required in the SOW for Task Order No. 1. The purpose of the meeting was to provide comments and engage in discussions regarding the 100% Draft Report submitted by Sverdrup to the Corps. These minutes will serve to outline the meeting. Detailed comments were provided to Sverdrup via the standard Corps review form (Form 32). For the most part, this meeting involved the discussion of these written comments and other general discussions relevant to the report. The completed forms have been attached and serve as the formal response vehicle for the written comments. Reference will be made to this form in these minutes and Sverdrup's responses will not be repeated in this text. Mr. Pankaskie's comments, which were received at the meeting, were not discussed in favor of allowing Sverdrup to address them upon their return to their offices and forwarding responses as a part of these minutes.

2. Ron distributed a copy of the agenda for the meeting (copy attached) and then began with introductions of the meeting participants. From Ron's agenda, we looked at Agenda Item 1a, and he asked if anyone needed a copy of the ITR review comments.

None were requested. We then looked at Agenda Item 1b which related to the schedule for Alternative 5 at Little Goose. Ron noted that Sverdrup had resubmitted the schedule in response to his review comments and the revised schedule seemed to make sense. There were no other comments.

3. Ron then asked Rolf if he had any issues he wanted to discuss related to Agenda Item 2a, the submersible pumps proposed for Alternative 5 at Little Goose. Rolf briefly described the issues as he saw them related to the submersible pumps. There have been some concerns expressed as to the selection of submersible pumps in lieu of lineshaft pumps which are more typical at the projects. This issue was raised by Sean Milligan in his review comments in regards to a perceived lack of support for these types of pumps by project staff (specifically at Lower Monumental) in an earlier report. Thus, there might be a similar resistance at other projects. No comments have been received from Little Goose with regards to this issue, so it is being discussed in anticipation of these negative comments. Rolf explained that from a concept perspective, the type of pumping equipment is less of an issue than whether the basic concept of Alternative 5 is attractive to the Corps. The design could be revised to accommodate lineshaft pumps instead of the submersible pumps. The submersible pumps were depicted because they resulted in the most efficient structure design, were lower cost equipment than lineshaft pumps, and were easier to remove (only need to pull them up). At this level of design development, even the design for the pump station showing the submersible pumps would likely change between this report and final plans. The report text will discuss in greater detail the options with regards to pump equipment selection for this alternative. Rolf gave Ron some literature from MWI on submersible pumps and noted that this information would be included in the DDR for the report.

4. We then talked about both Alternatives 1 and 5 and compared them. Both are attractive in Rolf's opinion. Sean felt that one of the attractive features of Alternative 5 is that the flow is dedicated to specific diffusers making the entire alternative very simple and straightforward. Rolf noted that this also reduces operational flexibility. We talked about the flexibility of use of the EAWS as a flow supplementation system to the AWS system. Rolf felt that Alternative 1 was more flexible in that regard. He further noted that the designs shown were not developed with use as a flow supplementation system specifically in mind. This led into a discussion about the hydraulics of the fishways at Goose and Granite. Sean said that he will be spending a good portion of next year working on the hydraulic issues at the fishways to resolve the hydraulic problems that have been identified so that current FPP criteria is better met under all conditions. Sean said that it was nice to have two viable alternatives (Alternatives 1 and 5) emerge from a report.

5. Ron then proceeded with the comment review responses. These are attached to the meeting minutes. Sverdrup had prepared responses to the comments ahead of the meeting and sent them to the Corps the previous day. The reviewers had an opportunity to review the responses and had a few additional comments on them. Kevin started the

process. He had questions about our responses to his comments No. 21, 22, 26, and 71. For comment No. 21, he asked for further clarification about the debris return pipe. Rolf explained that the intent was to run a 8 to 10-inch pipe along the upstream face of the powerhouse under gravity flow carrying the debris flushing flow to a location remote from the screen. It could be PVC or similar piping with standard pipe hangers. The idea is to route it far enough away to minimize the chance of it being reintroduced on the screen. Sverdrup did not intend to detail the pipe on the drawings.

On comment No. 22, we talked about the freezing issues for the screen. We talked about strategies for keeping the ice at bay. This included running the screens during cold weather to prevent the screens from jamming with ice. Rolf noted that the screens should not be operating during January and February. He also noted that since frazil ice is not a particular concern, and since the screen in predominantly underwater, the biggest issues is at the interface zone with the water surface. This should not be too hard to deal with.

On comment No. 26, Rolf explained that a lock-out of the sleeve valve appeared to be the only reasonable way to deal with the issue of preventing accidental filling of the supply pipe in Alternative 1 while the pump chamber is empty. This is rather standard procedure for the projects.

For comment No. 71, Rolf noted that we would look at the text and ensure clarity and consistency.

6. Ron then asked Dave what the project's plan was for Pump No. 1 at Granite. Dave said that the project is looking for direction (from Dave Hurson). There also appears to be the issue of how repairs to the pump will be funded. This was discussed to some decree.

7. We then talked about Sean's comments. He felt that Sverdrup had addressed his comments to his satisfaction.

8. Dave's comments were reviewed next. Dave only wanted to emphasis that in his comment No. 1, that failure of power to the wicket gate actuators will not cause the turbines to be shut down or go off line. Rather, it will only impact the automated control features of the actuators. The gates can be operated manually if necessary. For his comment No. 2, Rolf noted that we would add an explanation of the term "Service Factor" in the text of the report.

9. Karl had a few questions in addition to his review comments. He was interested in knowing how we proposed to install the steel structure for Alternative 2. Rolf noted that the report indicates that the approach would be to install it in panelized components for final fit-up underwater with divers. Karl said that was the way they did the SBC at Lower Granite. He asked about the installation of the perforated pipe in the pump chamber for Alternative 1. Rolf said that we would need to install it through the excavated opening in the concrete wall on the south side of the pump chamber. The pipe

would need to be support either through deck hatches or with temporary support steel inside the pump chamber. It might be supported from the floor of the chamber.

10. Ron asked if there were any other comments or questions. Hearing none, he closed the meeting at 11:30 AM. After lunch Rolf drove to McNary Dam to view the construction on the dewatering prototype.

Prepared By: Rolf G. Wielick

Rolf G. Wielick

Distributions:

Meeting Attendees
Jon Lomeland, COE
Perry Johnson, ENSR
Gerald Walker, DCV Consultants
David Absher, DCV Consultants
Project Files

Attachments:

Meeting Agenda
Submittal comment and responses from Sean Milligan, Ron Porter, Kevin Renshaw, Karl Pankaskie, Jon Lomeland, and Dave Embree

AGENDA for Review Meeting on the EAWS Little Goose and Lower Granite
Phase II – Technical Report with Sverdrup - Task Order #1
Review of 100% Submittal - 19 Sept., 2000 - 0930-1130 hours

0930-0940 **Introductions**

940-950 **General Comments Relating to the 100% Submittal**

1. from Corps' perspective:
   a. Good review comments submitted by Sverdrup ITR team. (copies to ?)
   b. Revised schedule for completion of Alt. #5, 2 years appears reasonable.
   c.

2. from Sverdrup's perspective:
   a. Submersible Pumps are they viable for Alt #5? Corps O&M issues?
   b. Option to the Alternative #5 for using different types of pumps.
   c.

0950-1100 **Review & Comment Discussion by Discipline – Corps Comments**

1. Mechanical - Renshaw
2. Structural - Lomeland
3. Environmental/Fish (NMFS questions)
4. Hydraulic – Milligan
5. Electrical - Embree
6. Cost - Pankaskie
7. General - Porter

1100-1130 **Summary of Recommendations & Agreements (Action Items)**

1. Little Goose
2. Lower Granite

Review Comments

Project: Adult Fishway System Phase II – Tech Report   Location: LGO & LGR

Date: 14 September, 2000 Reviewer: David G. Embree Telephone: 843-1493 x254			Page 1 of 1		
X NPW-EN-DB __ Air Force __ Army		**Design Document** _____D. Memo _____Concept _____BCOE P&S _____Prlim. _____60% ___X_Final **Discipline** _____Arch _____Civil _____Mech/Elec _____Struc	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick and Gerald Walker		
1	Pgs. ES-2 4-8 4-9 etc.	"Failure in the single source of power would leave turbines inoperative for an **extended period of time.**" The phrase "extended period of time" is used throughout the analysis (see pages listed). Failure of a power source would be a significant event and would vary in duration depending upon the cause and the fix. The phrase is rather vague. Recommend searching the document for the phrase and replacing it with a more specific wording, such as "… for the period of time required to complete repairs."	**A** – The text will be reviewed and clarification made as to what this means.		
2	Pgs. 5-5	Please define "Service Factor 2".	**A** – It is the "safety factor" for the piece of equipment, ie, if the required hp for a system is 1000 hp, a gearbox with a Service Factor of 2 would be rated for 2000 hp. An explanation will be added in the text.		
last	typos	Page 4-7 change "19915" to "1991" or "1995" Page 4-8 middle of bottom para. ".." Page 5-15 end of top para. ".."	**A** – The text will be fixed.		

Re[illegible]w Comments   Project: Aux Water Supp. 100%   **Location: L.Gran & L. Goose**

Date: 12-Sep-00 **Reviewer:** Jon Lomeland **Telephone:** 509-527-7652

XX NWW-EN-DB-ST
__ Air Force
__ Army

Design Document
__ D. Memo __ Concept
__ P&S __ Prlim.
__ __ Final

Discipline
__ Arch.
__ Civ.
__ Mech/Elect.
_X_ Struct.

REVIEW CONFERENCE
A-comment accepted
W-comment withdrawn
(if neither, explain)

DESIGN OFFICE
C-correction made
(if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
1.	ES-2 Little Goose alternatives	It seems like the paragraph could be changed, so that the 4th alternative is not referred to as the fifth.	**A** – The text will be revised to say "remaining" rather than "fifth".		
2.	4.4.4	For starting up the traveling screens for the gravity flow alternative the concluding paragraph says that the system could be started up in a relatively short time assuming there isn't debris. If a log or large piece of debris were to tear a screen at start up, how long would it take to get the system up and running? Assuming that the system couldn't be started until the screen was replaced.	**A** – The intent is to run the screens for a short period of time to flush the debris off via the screen spray system. The trash racks provided should keep most large floating debris from the area of the screens themselves. Should any large debris get between the trash racks and the screen and if the screen was damaged by the debris, the panel would be rotated to a position where it could be serviced and either fixed in place or removed and replaced with a new panel. It would seem that this should be something that should be fixable in less than half a day. This is not expected to be an issue given the configuration with trash racks depicted on the drawings.		
3.	Plate 1.1.3	What are the existing guides where the new gravity pipe is penetrating the dam used for? The drawing says it's an existing bulkhead guide. And note 1. Says to remove the guide where the pipe penetration is. Is the guide something that is going to be installed prior to the pipe and then removed? Or is it and existing guide that may be needed again in the future and will not be available?	**A** – The guides are no longer used. They were part of the temporary fish ladder which was used during construction of the dam.		

Review

Comments Project: Aux Water Supp. 100% Location: L.Gran & L. Goose

Date: 12-Sep-00	Reviewer: Jon Lomeland	Telephone: 509-527-7652			Page 2 of 2
XX NWW-EN-DB-ST __ Air Force __ Army		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. __ __ Final **Discipline** __ Arch. __ Civ. __ Mech/Elect. _X_ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
4.	4.5.2.2 d.	How do you split the flow from the pumps going into the water supply conduit when there is nothing in the conduit to separate it? It looks like it would all go to the same place.	**A** – The flow split occurs by controlling the amount of flow that is discharged through diffuser No. 12 at the north end of the powerhouse. By opening and closing that gate, more or less flow will be directed towards the gate.		
5.	4.5.2.4 b.	Is the 16 Kips/ft that is being transferred into the piers a vertical force or horizontal force? Are the piers adequate for the load?	**A** – This is a horizontal force. Based on preliminary reviews, the piers should be adequate for this load.		
6.	4.5.2.4 c.	Where is diffuser No. 12 located. I didn't see it shown on the plates.	**A** – On the north end of the powerhouse. It discharges flow from the North Shore Fishwater Conduit.		
7.	4.5.4	Operation and Maintenance issues. Could the whole screen system including the drive system mechanisms be all mounted on a unit that could be removable? The whole system could be pulled out like are existing fish screens at the dams for maintenance or inspections instead of using divers.	**A** – Possibly. This would make the maintenance aspects better. The development of the screen cleaner system is seen as a more complex engineering challenge as has been the case with other such cleaner systems developed by the COE.		
8.	4.9.3	It may not be possible to do the excavation for the installing the pump chamber in the time frame shown. It looks like it would almost have to be considered inwater work since it's so close to the tailwater. It might have to be done during the fish window.	**A** – Based on unit rates available from Means Cost Guides, this seems possible. As long as there is no discharge to the river, there should be no problem in performing the work a virtually any time of the year.		
9.	Plates general	The plates need a legend defining the line weights used for existing versus new features.	**A** – We will review this and clarify the drawings to make the distinction between new and existing construction more obvious. A legend would certainly be one way of doing it.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer: Kevin Renshaw** **Telephone: 527 7570**

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Design Document: __ D. Memo; __ P&S; __ 50%; X Concept; __ Prlim.; __ Final; X Tech

Discipline: __ Arch.; __ Civ.; __ Mech./Elect.; __ Struct.

REVIEW CONFERENCE: A-comment accepted; W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (Initials)
1	ES	General. The ES needs to be summarized; it is too long.	**A** – It will be trimmed down. The challenge is to make it meaningful and short, as you well know.		
2	ES	General. There is no schedule included in the ES.	**A** – The schedules will be summarized in the ES.		
3	General	There are multiple grammatical and typographical errors throughout the report. It should be proofread carefully and corrected. Sentence tense and plurality need to be corrected.	**A** – The document has not yet received our internal QA/QC check. Our aim is to make it error free!		
4	ES -1	Last sentence at the bottom of this page and continuing on ES-2 appears to be some sort of recommendation out of place.	**A** – Yes. We will take it out.		
5	ES-3	Description for alternative 3 is difficult to follow.	**A** – It will be reworded.		
6	ES-3 4-57	Last sentence under the description for alternative 5. Should open the new gates before starting the pumps, otherwise the new chambers will flood quickly. Bulleted list on page 4-57 seems to have the correct sequence.	**A** – Yes. The text will be revised to match 4-57.		
7	ES-3, ES-6	It may not be necessary here, but there was inadequate discussion between O&M funds and CG funds.	**A** – We will touch on that subject more.		
8	ES-3	Should state whether or not the cost of alternative 4 was included in the costs of the other alternatives, since it was recommended that it be part of the other alternatives. Otherwise, one has to sort through the estimates in the appendix.	**A** – The text will be made more clear. The cost summaries tables will note that it does not.		
9	ES-3	It is interesting to note that alternative 3, which sort of originated from a VE study, ended up being the most expensive alternative.	**A** – Yes. The lack of station service capacity appears to be the big killer.		
10	General	There is mention several places that the flow criterion of 1.5 fps is not met in some conduits. I did not find anywhere what the actual velocity in these areas is, nor did I see what was being done to try to improve the velocity. One example of what I am referring to is found on page 4-4.	**A** – We have not seen specific values either. We observed the low velocities and the deficiency was noted by		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00	Reviewer: Kevin Renshaw	Telephone: 527 7570			
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR		**Design Document** __ D. Memo X_ Concept __ P&S __ Prlim. __ 50% __ Final X_ Tech **Discipline** __ Arch. __ Civ. __ Mech./Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
			both District and Project staff. It is noted in the 1988 Hydraulic Evaluation that "powerhouse collection channel velocities in the vicinity of Units 1 and 2 may drop below the 1.0 fps minimum velocity. These collection channel velocities should be evaluated at a future date." It is apparent from the hydraulic studies that a considerable amount of uncertainty exists as to why these hydraulic deficiencies exist and what to do about them. It is also apparent that a considerably more detailed evaluation of AWS system hydraulics (independent of the EAWS system issues), including the pumping performance, flow control, leakage, potential obstructions, weir sill heights, etc, is warranted. Moreover, since the current FPP criteria is apparently less than the		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (If neither, explain)

DESIGN OFFICE: C-correction made (If not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
			biologists <u>really</u> want, a full review of AWS system operating criteria in the context of current performance and what would be required to support a modified FPP is necessary. Adding more water may help but system-wide performance and correction should be reviewed. These are issues that should be resolved before EAWS system improvements are made.		
11	ES-4 4-52	There are inconsistent references to the various alternatives benefiting by including alternative 4 with them. (Little Goose)	**A** – Yes. The text on 4-52 was written prior to the emergence of Alternative 5 (which appeared after the 60% meeting). The text will be made consistent. Alternative 5 should be included along with Alternatives 1 and 2 as benefiting from the addition of Alternative 4.		
12	ES-5	There appear to be some out of place recommendations on this page. First bullet item, and in the last paragraph.	**A** – The text will be revised.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
13	ES-5	The first 2 sentences of the second paragraph from the bottom of the page seem to contradict each other, unless I misinterpreted the difference between "reviewed" and "evaluated".	**A** – The intent was to make a distinction between "EAWS alternatives", which are ones that add spare capacity, and other alternatives which only increase the reliability of existing systems (ie, don't add spare capacity). This will be made more clear in the text.		
14	4-3	Last sentence of first paragraph. Should probably use "AWS pumps" instead of "fish pumps".	**A** – Yes. The text will be revised.		
15	4-4	Paragraph near the bottom of the page that starts out "The turbines. . ." has an incomplete sentence in it.	**A** – Yes. We will revise the text.		
16	4-5	Bullet items. There is no discussion as to whether the rehabbing and rebuilding improved the performance of the turbine pumps. I thought that it had improved the performance somewhat. The report cited further down the page was done before this work.	**A** – The rebuilding of the turbines would have improved performance. However, we did not see any reference to performance improvements in the project records. If such exist, we will add this information to the text.		
17	4-12	May want to add "from the Phase 1 report" after "Alternative 5" in the last paragraph on this page. A different "alternative 5" is pursued in this report.	**A** – Yes. The text will be revised.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

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Design Document: __ D. Memo, __ P&S, __ 50%, X Concept, __ Prlim., __ Final, X Tech

Discipline: __ Arch., __ Civ., __ Mech./Elect., __ Struct.

REVIEW CONFERENCE: A-comment accepted; W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
18	4-15	First bullet item at top of page. This process is a little confusing. It almost sounds like the new pipeline would be watered up only when the system was in use. Do we really want to have to go through the water up process every time the system is put in use? Also, unless the sleeve valve is left open, or the sluice gates have absolutely no leakage, water will collect in the pipeline. There might be full hydrostatic head on the sleeve valve all the time.	**A** – In re-thinking this procedure, it seems more reasonable to keep the pipe watered up at all times and leave the sleeve valve closed. The text will be revised.		
19	4-15	Describe what the screen material is. Mesh, bar screen, plastic, steel, etc.	**A** – The vendor that provided information on traveling screens has both metallic and non-metallic screen material available. The selection of material would be a final design item. NMFS screening guidelines allow mesh, perforated plate and bar screen without preference stated as to material type. The text will note this.		
20	4-18	The first sentence of the last paragraph points out that historically; travelling screens have had maintenance problems. The description of the traveling screen that follows seems to ignore, gloss over, and minimize these problems as it extols the virtues of the proposed design. There is not enough detail provided in the report for the reader to make a determination as to what maintenance problems could be anticipated with the proposed design. It might be wise to consult with other manufacturers. These same concerns apply to the discussion on pages 4-24 and 4-25 for the traveling screens.	**A** – The text notes that historically, travelling screens have had maintenance problems. One of the most critical areas has been the foot sprocket. The proposed screen design has a continuous guide rail eliminating the foot sprocket. It was the		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
			intent of the discussion to recognize some of the maintenance problems associated with some screen designs but, also recognize that advances in design have reduced these problems. The maintenance problems that could be anticipated would include problems with the belt assembly that drives the screen baskets, damage to the baskets themselves, drive assembly breakdowns, spray system breakdowns. The good news is that all of these components can be accessed from above the water surface which makes maintenance much more predictable. The text will be reviewed to confirm that our findings are fairly reflected in the text.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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REVIEW CONFERENCE — A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE — C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By
21	4-19	Provide additional details of the flushing water routing. The debris could end up getting reattached to the screen if it is dumped in the vicinity.	**A** – The intent is to route the debris as much as 30 to 50 feet away. Since the concentration of debris in the flushing water is expected to be quite low, the reintroduction into the forebay at a distance such as this should not present a problem with re-attaching. On the other hand, if it did reattach, it would simply be flushed of again.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

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Design Document: __ D. Memo, __ P&S, __ 50%, X Concept, __ Prlim., __ Final

Discipline: __ Arch., __ Civ., __ Mech./Elect., X Tech, __ Struct.

REVIEW CONFERENCE: A-comment accepted / W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (initials)
22	4-19	Is there a concern for icing of the screen in freezing weather, if so, what are the provisions that could be used to prevent this problem?	**A** – The system is theoretically not operational during January and February. Thus, these months are not of particular concern. Frazil ice should not be a problem given the quiescent nature of the forebay. Surface ice, and damage caused by surface ice, should be thwarted by the trash racks and by operating the screens during very cold weather to prevent ice from accumulating on the screens. The text will be revised to address this issue.		
23	4-20	The 90" pipe in the forebay needs to be able to withstand an external head of 41 feet if I read this report correctly.	**A** – Yes.		
24	4-20	It is not clear how the 90" pipeline would be watered up. Through the sluice gates (open/close) or some regulated path?	**A** – There should be a pipe fill line included. This could be a rather small pipe. The text will note this.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

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DESIGN OFFICE: C-correction made (if not, explain)

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Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
25	4-20	Paragraph starting out "The 90-inch. . ." talks about both a mortar lined pipe and an epoxy lined one. It is confusing what the intent was here.	A – The text will be clarified. Either system could be used. The pipe was priced from the manufacturer with an epoxy lining.		
26	4-21	Paragraph at the top of page. If there is any possibility that the diffuser pipe could be filled (perhaps accidentally) with the pump chamber empty, the supports should be designed for it. It seems like this could happen if the sluice gates and sleeve valve were accidentally opened at the wrong time.	A – This would have to be a lock-out item during dewatering of the pump chamber. This would be one of many such locked-out items during pump chamber dewatering.		
27	4-23	Paragraphs starting "The electrical. . ." and "This system. . .". It is confusing as to whether there are 4-480v circuits total or just 2-480v circuits total.	A – The intent is to provide one 480V circuit to each the upper and lower areas (two total). Dual circuits to both locations is not considered necessary for EAWS service. The text will be revised.		
28	Plates	General. Use only graphic bar scales on the plates. Do not use written scales.	A – OK. The written scales sure are handy.		
29	Plates	General. It is fairly clear what is new and existing using the different line symbology, but a legend would be helpful to confirm the different line symbology.	A – Yes. We will add a legend.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

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REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
30	Plate 1.1.3	Will there be any annunciation for screen plugging? There are no details on the screen guides, drive system, debris removal system, screen material, or screen panel mounting arrangement. The DDR does not contain any catalog information on this system.	**A** – The lack of annunciation was mentioned in the ITR, also. The text will be revised to note that. A copy of the vendor information on the screen will be added to the DDR in the cost estimates (typical costs).		
31	Plate 1.1.3	Explain the provisions for removing and/or cleaning the trashracks.	**A** – It was envisioned that the racks would be cleaned in the same manner that the AWS intake racks are cleaned. According to the project, they are lifted clear of the guides and "schwooshed" off in the water with a crane. Residual material is picked clean by hand. This will be noted in the text.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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REVIEW CONFERENCE
A-comment accepted
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DESIGN OFFICE
C-correction made
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Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (Initials)
32	4-29, 4-31, 4-36	Several references are made on these pages to model studies during design. The estimated cost of these studies should be included in the design cost.	A – It was intended that the "Planning and Engineer" allocation of 22.5% of the total construction cost would cover modeling. At this level of detail, it is difficult to establish directly these costs. The estimates will be reviewed for adequacy with regard to modeling (which can get quite pricey as you well know).		
33	4-33	Last few sentences of paragraph starting "Fishwater conduit. . .". It sounds like the gates would be designed for some unseating head. One of the sentences says there is no unseating head, the others say there is.	A – The text will be revised to eliminate this discrepancy.		
34	4-33	Later in the report it talks about the construction tolerances of the existing concrete and the desire to make things somewhat adjustable to account for it. Additional work may be necessary to get a good seal with the draft tube bulkhead slot plugs. There could be a lot of leakage here.	A – Yes. The design we have for these should be fitted with a compressible seal to minimize this leakage. This may not be sufficient and further treatment may be necessary. The text will note this.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report Location: Granite/Goose

Date: 14-Sep-00 Reviewer: Kevin Renshaw Telephone: 527 7570

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REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
35	4-34	The vertical brush system described for the proposed dewatering screens will be operating under quite different conditions than the ESBS do. Not sure how far one can go with the comparison here. Also, the ESBS brushes brush the screen in both directions of travel. The ESBS brush bars have been damaged by debris, brushes in the "flow path" here would also seem susceptible to damage.	**A** – It would seem that the sweeping velocities typically found in the intakes at the face of the ESBS would be higher than would typically be found here in the backroll of the turbine discharge. Local temporary velocities may approach those of the ESBS by sustained velocities are not likely. Also, the turbine discharge has an advantage of having been passed through the ESBS and vertical barrier screens (at least a good deal of it). Maybe debris will be less significant at the tailrace.		
36	4-34, 4-40 Plate 1.2.2	Very little detail was given as to how the screen cleaners and screen panels could be removed. The plate does not seem to show provisions for this. Page 4-34 says the "entire mechanical system for the cleaners" can be removed, page 4-40 says "the cleaner drive mechanism will require diver inspection". These seem to be contradictory. Suggest moving the screen cleaner drive machinery to the top of the structure so it is out of the water. Also, commercial screen cleaners for this type of screen may also be available.	**A** – The drawings (Plate 1.2.1 and 1.2.2) don't show a removable cleaner drive system. A removable screen panel system is shown in Detail 1 on Plate 1.2.1. The text will be revised to make the two consistent. Suffice to say that in the final design of this		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
			system, a panelized screen system with a removable cleaner (including drive system) could be devised. This would make maintenance of the system much easier. The text will note that this feature should be investigated in final design. The components of the drive mechanism that are currently proposed to be underwater (with the depicted design) would be the chain guide mechanisms, idler sprockets, etc. The actual motors would be above the water surface.		
37	4-35, 4-36	The cost of the predation prevention panels should be included in the estimate if there is a good chance they would be necessary.	**A** – It is not felt that there is a good chance of this being necessary. Thus, they were not included.		
38	4-37	First sentence of second paragraph seems to contradict what the paragraph preceding it says. Maybe add "from the same bus" to the end of the sentence.	**A** – Yes. The text will be revised.		
39	4-38	Concerning the screen cleaners. It is possible that the reason the screen cleaning system for this alternative is not as "clean" as that of alternative 1 is because more is known about this screen cleaning system than that for alternative 1. Reference comment # 20.	**A** – Actually, the number of traveling screen systems in operation probably far outnumbers the number of brush bar		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

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REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
			systems driven by chain or cable drive systems. The existing traveling screen at McNary is an example of one that the Walla Walla District operates successfully (except for the recent rehabilitation when an unusual loading condition failed the screen, as we understand it). The fact that these types of screens are vendor-supplied items shifts the design responsibility to the manufacturer. This is an advantage from a cost standpoint in that the screening system does not need to be designed by the COE, tested, modified, adjusted, re-tested, etc. to get it to work right.		
40	Plate 1.2.1	It seems the pump spacing would be more evenly divided if the pumps were on 20.75' centers instead of 26' centers. It would also center the pump intakes better in the screen panels.	**A** – Yes.		
41	Plate 1.2.2	Section A. It looks like the 12" dimension for the opening should be 12'.	**A** – Yes. This will be corrected.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report Location: Granite/Goose

Date: 14-Sep-00 Reviewer: Kevin Renshaw Telephone: 527 7570			Page 15 of 26		
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR		**Design Document** / **Discipline** __ D. Memo X Concept __ Arch. __ P&S __ Prlim. __ Civ. __ 50% __ Final __ Mech./Elect. X Tech __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
42	General	It is not clear why vertical motors were recommended for alternative 3 and horizontal motors were recommended for alternative 2.	**A** – The pumps for Alternative 2 are also available with the motor vertical. The right angle gear and horizontal motor arrangement was selected because of concerns about excessive height potentially causing operational interferences given the fact that cranes and other equipment utilize that area. Vertical motors were selected for Alternative 3 to eliminate the right angle gearbox with its higher costs, complex construction and more difficult alignment problems. There would also be problems with floor space for horizontal motors if Option 2 were selected.		
43	Plate 1.2.2	Will there be any annunciation for screen plugging? The DDR does not contain any catalog information on this system.	**A** – Water surface differential monitoring would be the recommended method of annunciation. The text will note this.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
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Design Document
__ D. Memo
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X Tech

Discipline
__ Arch.
__ Civ.
__ Mech./Elect.
__ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (Initials)
44	4-42	The replacement of the turbine pumps definitely does not comply with the 5th bullet item.	**A** – The 5th bullet item refers to areas of the powerhouse outside of the pump house. However, the comment is correct in that new substations and extensive conduit runs are also required. Best is to delete the 5th bullet item as it really does not apply.		
45	4-43	Should check on the 4' head number. It seems the existing system is already operating at higher heads and cannot get the flow out. Trying to get more flow out will take even higher heads. I think this information is available in one or more of the hydraulic evaluations. Even larger motors may be necessary.	**A** – This will be reviewed. It is apparent through the development of this report that a comprehensive review of the hydraulic performance of the entire AWS system at Goose and Granite needs to be conducted independent of the EAWS effort. Recent hydraulic studies of the systems are somewhat inconclusive as to what the problems are. Coupled with this would be a review of the biological needs of the system to effectively pass fish. The FPP (as currently written) seems to describe operating		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00	Reviewer: Kevin Renshaw	Telephone: 527 7570			
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR		**Design Document** __ D. Memo X Concept __ P&S __ Prlim. __ 50% __ Final X Tech **Discipline** __ Arch. __ Civ. __ Mech./Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		

			conditions less than what the biologists really want and given that the existing AWS system only nominally conforms to the FPP at the north shore fish entrance, the system should be reviewed in the context of what the biologist would really like to have.		
46	4-45	The costs for the model studies and etc. should be included in the estimate.	**A** – See response to Item 32.		
47	4-46	First paragraph. The existing turbines and draft tube expansions would be removed even if the penstock was not going to be used.	**A** – This was written in response to a proposal by CH2M Hill in their report for LoMo which showed the turbine and draft tube expansions left in place. This may have changed since the report we saw at 60%.		
48	4-47 Plate 1.3.2	HVAC. For the HVAC system to be effective, motor enclosures will almost certainly be required. The fan coil units mounted on the floor will circulate cooler air, as the warm air will rise to the ceiling. There needs to be some method of removing the heat at its source. May want to take a closer look at what is done at Lower Granite.	**A** – The design and cost estimates envision a system of supply and return ducts for proper distribution of the cooling air ducts to distribute and return air. The text and drawings will be expanded to show this.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

NWW-EN-DB-ME
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Design Document: __ D. Memo, __ P&S, __ 50%, X Concept, __ Prlim., __ Final

Discipline: __ Arch., __ Civ., __ Mech./Elect., X Tech, __ Struct.

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
49	DDR	Reference above comment. The powerhouse HVAC system will try to maintain a temperature lower than 95 (70 to 80) in the powerhouse. If enclosures are not used, this cooler air will be circulated through the fan coil and they will not be effective when the river water is warm.	A – We do not have specific information on the plant HVAC system. If 95 F is not acceptable and the plant system cannot be adjusted to accommodate this, then water could be supplied by the plant's chilled water system (if there is enough capacity) or separate raw water cooled condensing units could be provided. We assumed about a 70F raw water temperature and nominal temperature rises through the raw water coils. Detail assumptions are covered in Calculation No. CE-01-0215.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report Location: Granite/Goose

Date: 14-Sep-00 Reviewer: Kevin Renshaw Telephone: 527 7570

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Design Document: __ D. Memo, __ P&S, __ 50%, X Concept, __ Prlim., __ Final, X Tech

Discipline: __ Arch., __ Civ., __ Mech./Elect., __ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check
50	4-50	The sentence reads "Increasing the pump flow from 850 cfs to 1275 cfs with the existing waterways increases the suction intake and discharge velocities 140 percent." This is true, but I am not sure what the point of the sentence is, seeing as how there would only be 2 of the 3 pumps operating at a time and the total flow would be about the same as it is now.	**A** – The referenced velocity increases occur in the individual pump suction passage after the common mixing chamber. Therefore the number of pumps operating has no effect on this area. We believe it is important to note the velocity increases as a flag for final pump selection.		
51	4-51	The last few sentences of the first paragraph on the page seem to disagree somewhat with the 4^{th} to the last paragraph on the page (concerning impacts to the AWS operation). Moderate may not be the correct word here if it is the correct word for other comparisons made on this page.	**A** – We believe the impacts on the "dam" as a whole would be moderate, since construction is mainly confined to the pump house and erection bay. The text does note the disruption while installing the new substations.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00	Reviewer: Kevin Renshaw Telephone: 527 7570				
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR	**Design Document** __ D. Memo X Concept __ P&S __ Prlim. __ 50% __ Final	**Discipline** __ Arch. __ Civ. __ Mech./Elect. X Tech __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
52	4-52	The second paragraph talks about one of the pumps being operated at a reduced speed. There is no other reference the pump motors being operated at more than one speed. Explain how this fits in with the rest of the discussion for alternative 3.	**A** – Agree the text is not clear. The planned EAWS pumping system would use single speed motors. If supplemental water was to become a criteria (not the present case), then making one of the pumps two-speed would be appropriate. The text will be revised to clarify that two-speed operation is a future possibility.		
53	Plate 1.3.1	The hatching for removal of items should probably cover the entire pump assembly in section A and the complete pump outline in the demolition plan.	**A** – Yes. The drawing will be revised.		
54	Plate 1.3.2	Fishwater Pump Room Plan. Should show the outline of entire new pumps and concrete with bold line work instead of just the new motor and gearbox.	**A** – Yes. The drawing will be revised.		
55	4-56	The two bulleted items starting with "The new pump. . ." and "The pumps. . ." are repeated in the list.	**A** – Yes. These will be corrected.		
56	4-56	Alternative 5 does not measure up to items 4 and 8 of the bulleted criteria list items.	**A** – Yes. For Item 4, it says "if possible". For Item 8, we believe that there really are a minimum of system configuration changes.		
57	4-58	From the DDR it appears that the TDH for the larger pumps should be 7.9'.	**A** – This will be reviewed.		
58	4-58	The cost of the model study should be included in the cost estimate.	**A** – See response to Item 32.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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Discipline
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__ Civ.
__ Mech./Elect.
X Tech
__ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
59	4-59	The discussion on this page makes one wonder why submersible pumps weren't also used for alternative 2.	A – Yes. The text should note that line-shaft pumps would also be an option (the ones shown for Alternative 2). The text should be revised to reflect that the choice of submersible pumps in this case was made to gain the most efficient structure design. The configuration of Alternative 2 did not seem to have the same advantages although it is noted in 4.5.2.3.a that submersible pumps would be an option to consider. In the long run, the selection of pump type may have more to do with the preferences of the COE based on operating experience, etc. than anything else.		
60	4-59	The sentence containing the pump cost seems out of place on this page.	A – Yes. This will be deleted.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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Design Document
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X Tech __ Struct.

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE A-comment accepted W-comment withdrawn (if neither, explain)	DESIGN OFFICE C-correction made (if not, explain)	Back Check By: (Initials)
			Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
61	4-59, 4-60, 4-61	Should confirm that the existing intake cannot be dewatered. I think the trashracks can be removed and stoplogs installed to dewater it. Sluice gate unseating head and structure design would need to be adjusted as appropriate.	**A** – This was confirmed with Ray Eakin at Little Goose who noted that only trashracks are available at the intake entrance.		
62	4-60	The "smaller" chamber as described is actually larger than the other chambers. Perhaps it should refer to the smaller pump size.	**A** – Yes. The text will be revised.		
63	4-61	The construction cost estimate should include the cost of "Water pumped from the excavation will need to be routed away from the river for disposal." This could be difficult to accomplish.	**A** – This can be accomplished in a number of ways depending on the volume of water encountered. Methods include development of water sprinkling systems that water adjacent lands. This is difficult to assess in terms of cost since the total volume of water is unknown. The $50,000 dollars included is considered to be appropriate for this level of detail.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer:** Kevin Renshaw **Telephone:** 527 7570

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Design Document		Discipline
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__ P&S	__ Prlim.	__ Civ.
__ 50%	__ Final	__ Mech./Elect.
	X Tech	__ Struct.

REVIEW CONFERENCE: A-comment accepted; W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (Initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check By: (Initials)
64	4-61, 4-64	It seems that the difficulty of removing the concrete under water has been minimized. Is it really that easy?	**A** – Easy may not be the word for it, but it is technically feasible and the methodology is well known. The work at Wanapum Dam in 94/95 was under a contract that Sverdrup provided a design for. In that design, a caisson was designed but the contractor opted to do the work underwater.		
65	4-62	First sentence in next to last paragraph. It looks like "from a single bus" should also be added here. Similar to comment 38.	**A** – Yes. The text will be revised.		
66	4-62	Last paragraph about VFD's. It is not clear what the reader is supposed to get from this paragraph. Information is given, but nothing is done with it.	**A** – The text will be revised to delete this discussion. It is not relevant to the design.		
67	4-64	Plates show a 96-inch hole instead of a 90-inch hole.	**A** – The text is wrong. It will be corrected.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer: Kevin Renshaw** **Telephone: 527 7570**		**Page 24 of 26**
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR **Design Document:** __ D. Memo, __ P&S, __ 50%, X Concept, __ Prlim., __ Final **Discipline:** __ Arch., __ Civ., __ Mech./Elect., X Tech, __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Review Conference	Design Office	Back Check By: (Initials)
68	4-65	Some things to consider regarding alternative 5. a. It might be better to use large diameter pipe sections (such as concrete cylinder pipe) for the pump upwells instead of a concrete walled structure. Pipe branches could be used to direct the flow into the diffusers. Construction might be faster and less expensive this way. Design effort might be less. b. Butterfly valves could be used instead of the sluice gates if pipe was used. They might be less expensive. Round holes might be less expensive to make than square ones. c. The small pump could be moved somewhat to make connections easier if pipe was used. d. Guides could be added to the ID of the pipe for installing the pumps and drilling the holes in the roof of the intake. The use of divers might be reduced this way, or eliminated for maintenance. e. Some sort of remote pump latching device could be developed to hold the pumps in place. This might also eliminate the need for divers for maintenance.	**A** – Yes. Thanks for your thoughts. If this goes to final design, we would certainly want to look at refinements to the proposed design. Ron has talked about a BCOE review prior to the final design phase to talk through these issues with the operators, construction division, and engineering.		
69	4-67	I agree with the recommendation to go with alternative 5. It seems to have the least number of hang-ups of the alternatives described.	**A** – Yes.		
70	5-6, 5-11	The sentence on page 5-6 says "The pumps have been well maintained through the years." It appears maintenance could have been better based on the listed problems discovered. It seems these problems could have been noticed and corrected (with good maintenance) prior to the attempted pump test. It appears that preventative maintenance on pump 1 could have been elevated to an even higher level; reference discussion on page 5-11. This is also evident in that pump 1 has been "inoperable" for several years for an unknown reason and the backspin device has some sort of problem.	**A** – Yes. We might want to qualify that statement.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report Location: Granite/Goose

Date: 14-Sep-00 Reviewer: Kevin Renshaw Telephone: 527 7570

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Design Document		Discipline
__ D. Memo	X Concept	__ Arch.
__ P&S	__ Prlim.	__ Civ.
__ 50%	__ Final	__ Mech./Elect.
	X Tech	__ Struct.

REVIEW CONFERENCE: A-comment accepted, W-comment withdrawn (if neither, explain)

DESIGN OFFICE: C-correction made (if not, explain)

Back Check By: (initials)

Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher

Item No.	Drawing Sht. Spec. Para.	COMMENTS	REVIEW CONFERENCE	DESIGN OFFICE	Back Check
71	5-8, 5-14	Next to last sentence in last paragraph on page 5-8 and discussion on page 5-14. There appears to be some confusion in the wording as to the level of redundancy needed. Failure of bus 2 would result in loss of only one pump, it still would be possible to operate pumps 2 and 3, which is not contrary to the general criteria. Not having spare capacity during the occurrence of a (single) failure is within general criteria. With the proposed design, it will still not be possible to run all 3 pumps if there is a bus failure, this is also true for the failure of bus 2 under existing conditions.	**A** – Yes, but failure of Bus 1 would result in the loss of Pumps 2 and 3. This single failure mode is not acceptable because less than 2 pumps (the minimum required to meet FPP criteria) would be available. This is the condition we need to avoid. There is no need to be able to run 3 pumps to meet criteria, so this is a non-design condition.		
72	5-12 to 5-15	The wording on this page almost sounds like what would be expected for a "recommendations" section. Maybe change "should" to "would" and then reword the "recommendations" section if necessary. The format of the entire section on alternative 1 is different than the other alternative sections.	**A** – Yes. We will review the text and revise as necessary.		
73	5-13	Why not send the backspin device in now while the pump is not ready to operate anyway? That way, it would be ready for testing when the end of the season comes. It would not be necessary to purchase a new backspin device that way. There already is an entire spare gearbox.	**A** – Good idea. We will review this and make the recommendation.		
74	5-14	First paragraph. The Falk gearbox will also work on pump one, with some additional installation delay.	**A** – Yes. The text will be revised.		
75	5-15	The transformer has failed 5 times? Is it not possible to get a more heavy duty one that won't keep giving out?	**A** – We will review this.		
76	Appendices	Appendix pages should be numbered.	**A** – The final report will have the pages numbered.		
77	Appendices	Review comments should have backcheck initials.	**A** – Yes.		

Review Comments

Project: EAWS Granite/Goose 100% Phase 2 Report **Location:** Granite/Goose

Date: 14-Sep-00 **Reviewer: Kevin Renshaw** **Telephone: 527 7570**				**Page 26 of 26**
NWW-EN-DB-ME __ Air Force __ Army 100%Comments_KR	**Design Document** __ D. Memo X_ Concept __ P&S __ Prlim. __ 50% __ Final	**Discipline** __ Arch. __ Civ. __ Mech./Elect. X_ Tech __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick, Perry Johnson, Gerald Walker, and Dave Absher		
78	Estimate	Lower Granite alternative 1, page 1. Spare parts inventory at bottom of page should have the same cost in the "unit cost" column and in the "total cost" column.	**A** – Yes. This will be corrected.		
79	5-19	I agree with the recommendation to go with alternative 1.	**A** – Yes.		
80	General	Despite all my comments, in general I was favorably impressed with the report.	**A** – Thanks for your valuable comments.		

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Comments   Project: Gr/Goose EAWS-Phase II Tech Rep 100%   Location: Granite/Goose

Date: 18-Sep-00 Reviewer: Ron Porter Telephone: 509-527-7519			Page 1 of 1		
XX NWW-ED __ Air Force __ Army		**Design Document** __ D. Memo __ P&S X 100% Tech Report **Discipline** __ Concept __ Arch. __ Prlim. _X_ Civ. __ Final __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(If neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
1.	ES-1	Last bullet - should this say, “turbine-pump gear-box”	**A** – Actually, the intent was for it to say “turbine/gearbox/pump”. The text will be revised.		
2	Pg. 4-7	Date should be 1995 not 19915	**A** – Yes. The text will be revised.		
3	Pg. 4-22	Para c. says a coffer cell would be required on the U/S face, shouldn't the correct term be a caisson. Then make sure there is adequate $$ to account for this item, there may be some used ones at Corps projects, but I doubt it – and they are quite expensive to fabricate.	**A** – Yes. The text will be revised.		
4	Pg. 4-22	Para c. this first para needs some rewriting. Working on the D/S face of the dam in Winter will present a lot of weather related problems, consider the slow going in your estimates for any work planned during that timeframe.	**A** – The text will be revised to caution about weather-related construction difficulties if construction is conducted during winter months.		
5	Pg. 4-26	Other Issues para.– rewrite 2nd sentence	**A** – Yes. The grammatical errors have been corrected.		
6	Pg. 4-69	This schedule is not realistic. Even if design could be done in the 99 days shown there is no time for BCOE review, advertisement, bid, award, etc. Plus there will need to be a NMFS consultation (60-90 days). After award the contractors normally take a couple of months to get their submittals in, and there is a lag to procure materials. Assuming design could start in 2001, I doubt if construction could start before 2002. Completion at best may be March 2003, (there is no need to expedite this job to improve fish passage such as the case with RSW, or the other Granite fish passage improvements jobs.) I think the current SCT worksheet indicates that all EAWS work at the 4 projects will be completed by 2004, due to funding profiles.	**A** – The schedule will be revised to reflect your comments. A revised schedule is being forwarded for your comments prior to the final report submittal.		
7					

Review Comments

Project: Phase II EAWS **Location: Granite/Goose**

XX NPW-EN-DB-HY __ Air Force __ Army		**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. XX 100% __ Final **Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (initials)
Date: Sept. 6, 2000		**Reviewer: Sean Milligan** **Telephone: (509) 527-7535**			**Page 1 of 4**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
		Content Comments			
1.	4.6.3.6	How will the system operate after the 1st year? At that time there will be 1 new (larger) pump and two existing (smaller) pumps. Any combination of just two pumps will not provide enough water. Will all three pumps operating, with one being the larger pump, provide too much water? Probably not, since it seems the fishway can never have too much water, but should discuss. (i.e. how should diffuser settings be adjusted; what are effects on velocities, turbulence, etc, in the distribution system; etc.)	**A** – System operation during the construction phase will be discussed in the text. Flow can be adjusted in the existing turbine-driven pumps by adjusting the wicket gates.		
2.	4.6.5	Other Issues, p. 4-52. Will Pump 1 have a variable speed drive or two-speed motor to allow it to run at "low speed"? I didn't see this discussed in previous sections describing the proposed system.	**A** - Variable or two speed operation is not required for basic FPP operation. If supplemental water supply is desired, variable or two speed could be incorporated. Cost estimate does not include this. The text will be revised to include this discussion.		
3.	4.8.1	2nd to last bullet. Do you mean the new pump intake (within the existing pump intake) should also have a debris rack, in addition to the existing one? I don't think a second debris rack would be necessary. However, if you do want additional new debris racks here, need to amend 4.8.2.3.c on p. 4-59. If you're referring to the existing trash rack, you can probably delete this as a criterion since the rack is already there and you've already included a criterion stating this alternative would utilize the existing pump intake.	**A** – This criteria statement will be deleted. The intent is for the existing rack to perform the debris screening.		
4.	4.8.2.1	Should make sure and get project maintenance personnel comments regarding submersible pumps. I remember they didn't like the idea of using submersible pumps for LoMo.	**A** – Yes. We would like to discuss this in greater detail to identify the nature and basis for these concerns.		
5.	4.8.2.1	Need to explain that the discharge volumes supplied by the new pumps to Diffusers 1 & 2 are close to the existing flow demands for those diffusers.	**A** – Yes. The text will be revised.		
6.	4.8.2.4.b	"smaller" and "larger" seem backwards with the numbers – the chambers for the "larger" pumps are 23 ft long and the "smaller" chamber is 36 ft long (same width & height).	**A** – Yes. The text will be revised. The "smaller" pump chamber got larger as the concept evolved and the text stayed the same…		

Re●ew
Comments Project: **Phase II EAWS** **Location: Granite/Goose**

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. XX 100% __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date: Sept. 6, 2000	**Reviewer: Sean Milligan**	**Telephone: (509) 527-7535**		**Page 2 of 4**	

Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by: Rolf Wielick		
7.	4.8.2.5.a	2nd para. "There are disadvantages associated with permanently connecting the motors to the two busses..." Such as? Maybe note what some of the disadvantages are.	**A** – In the case where one of the station service busses is unavailable, the pumping station will not be able to provide sufficient flow. The shortfall would also depend upon which of the two busses failed, since Bus 1 has one 500 horsepower pump, and Bus 2 has one 300 and one 500 horsepower pump connected. The text will be revised to include this discussion.		
8.	5.2.2.2	3rd para. after bullets. "During tests run at normal tailwater elevations ... all pumps apparently operated with no problems." Should note that these tests were relatively short duration, all three pumps were on simultaneously less than ½ day.	**A** – Yes. The text will be revised.		
9.	5.2.2.2	3rd para. after bullets, last sentence. "Another problem with three-pump operation <u>at low tailwater elevations</u> is the limited..." Add underlined phrase. At higher tailwater elevations, there is sufficient diffuser capacity to pass the higher discharge since the lower fish ladder diffusers also pass water then.	**A** – Yes. The text will be revised.		
10.	60% ITR comments by Kelly Freeman	It does not appear that Comment #10 has been addressed either in the text of the report or in the plates as indicated by the response to the comment. I agree that there should be some provision added for access for inspecting/maintaining the pipeline.	**A** – This issue was addressed in Section 4.4.2.3.c, 1st paragraph, 2nd to the last sentence. We have not shown it on the drawings.		

Review Comments

Project: Phase II EAWS **Location: Granite/Goose**

XX NPW-EN-DB-HY __ Air Force __ Army	**Design Document** __ D. Memo __ Concept __ P&S __ Prlim. XX 100% __ Final	**Discipline** __ Arch. XX Civ./Hydr. __ Mech/Elect. __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date: Sept. 6, 2000	**Reviewer: Sean Milligan**	**Telephone: (509) 527-7535**			**Page 3 of 4**

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick		
11.	60% ITR comments by Mizan Rashid	It does not appear that Comments #1 & #5 have been addressed in the text as indicated by the responses to the comments.	**A** – Comment #1: We chose to deal with this outside of the report since we did not feel that this issue had any relevance. We will mention it briefly in the report text to cover it. Comment #5: This is not an issue since the trash bars (as originally configured) were smaller than the vaned openings. With the evolution to a screened intake for fish, this issue has gone away completely. This is not a relevant issue and we chose not to introduce it into the report.		
		Editorial Comments			
1.	ES-3	Alt. 3. "…electric motor-driven pumps where in which operation…" Delete the word "where".	**A** – Yes. The text will be revised.		
2.	ES-4	4th para., last line. "…from an AWS…" – "a" should be "an".	**A** – Yes. The text will be revised.		
3.	p. 4-51	1st para. "barring" is misspelled.	**A** – Yes. The text will be revised.		
4.	p. 4-51	2nd para., 1st line. "construction time are removing…" – replace "is" with "are".	**A** – Yes. The text will be revised. The word "include" is being substituted.		
5.	p. 4-56	Delete the 7th bullet (redundant to the 2nd bullet)	**A** – Yes. The text will be revised.		
6.	p. 4-56	1st para. after bullets, 1st sentence. "…currently utilized by the existing three …" Add the word "the".	**A** – Yes. The text will be revised.		
7.	p. 4-57	4.8.2.2.a "…focused on evaluating the influence…" Add the word "the".	**A** – Yes. The text will be revised.		
8.	p. 4-60	2nd para., 3rd to last sentence. "These openings accommodate the pumps." Add "s" to "opening" to make it plural.	**A** – Yes. The text will be revised.		
9.	p. 4-61	1st line. "…the structure is designed in a…" Add "ed" to "design".	**A** – Yes. The text will be revised.		
10.	p. 4-61	1st para. of Concrete Removal, 2nd sentence. "…coffer cell that can be floated…" Add "be".	**A** – Yes. The text will be revised.		
11.	p. 4-62	1st para., 2nd to last sentence. "…has been replaced with a hydrostatic…" Add a "d" to "replace".	**A** – Yes. The text will be revised.		

Re w Comments   Project: **Phase II EAWS**   **Location: Granite/Goose**

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Date: Sept. 6, 2000	**Reviewer: Sean Milligan**	**Telephone: (509) 527-7535**		**Page 4 of 4**	

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by: Rolf Wielick		
12.	p. 4-63	1st para. "…switchgear, through the existing high voltage…" "though" should be "through".	**A** – Yes. The text will be revised.		
13.	p. 4-67	3rd to last para. "…from an AWS…" – "a" should be "an".	**A** – Yes. The text will be revised.		

Review Comments Project: Emergency Auxiliary Water Supply **Location:** Little Goose & Lower Granite Dam

XX NPW-EN-DB-CB __ Air Force __ Army	**Design Document** / **Discipline** __ D. Memo __ Concept __ Arch. __ P&S ___ Prlim. __ Civil __ CDR _90%_ Final __ Mech/Elect. _x_ Costs __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**			**Page 1 of 6**

Item No.	Drawing Sht. Spec. Para.	COMMENTS	Action taken on Comments by:		
1.	Alt 5 Estimate Page 1	Are the costs for disposal of demolition AC Paving is not included in the price? (Seem low due to site location)	**A** – We will review these costs.		
2.	Alt 5 Estimate Page 1	Because to the depth and tight execution requirements and hauling off material, the excavation and hauling off price is too low.	**A** – We will review these costs.		
3.	Alt 5 Estimate Page 1	Per your drawing reference, 25' x 110' x 45' depth hole and only needing two sides braced, you seem to need more bracing than calculated. (See backup sheets 2)	**A** – Only one side has shoring. That is the side adjacent to the fishway. The side adjacent to the intake headwall has been fully excavated leaving just the concrete headwall. The downstream side is excavated at a 1:1 slope.		
4.	Alt 5 Estimate Page 1	What is the type of shoring being installed?	**A** – The shoring at the fishway side could be horizontal steel girders with vertical timber planking. The girders would be bolted to the fishway support walls that extend to bedrock.		
5.	Alt 5 Estimate Page 1	Depending on the type of shoring, you seem to be missing shoring removal costs?	**A** – Depending on costs, the shoring could be buried in the excavation.		
6.	Alt 5 Estimate Page 1	For an approximate 30' dewatering job and the length of time it will be dewatered, the $50,000 seems a little low for total costs.	**A** – We will add $50,000 to the cost. I think you are right.		
7.	Alt 5 Estimate Page 1	For concrete wall and elevated slab place with the water surfaces pointed & patched for fish protections, the concrete unit costs seem vary low. You may need some sort of scaffolding costs too. Is the top slab precast? Note: The concrete supplier travels a long distance to get to site which increasing the mix costs.	**A** – There are no fish protection issues since fish are not in the supply water. The cost estimate is not detailed enough to account for scaffolding and The unit costs for the concrete are high for slabs and walls and more in line with beams. I think we are pretty well covered.		
8.	Alt 5 Estimate Page 1	Is the misc. steel galv or SS steel this may also increase costs?	**A** – Our thought was that it would be galvanized.		

Rev Comments Project: Emergency Auxiliary Wate pply **Location:** Little Goose & Lower Granite Da

XX NPW-EN-DB-CB __ Air Force __ Army		**Design Document** / **Discipline** __ D. Memo __ Concept __ Arch. __ P&S ___ Prlim. __ Civil __ CDR 90% Final __ Mech/Elect. _x_ Costs __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**				**Page 2 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
9.	Alt 5 Estimate Page 1	Because of the Corps requirements for the 6" lifts compaction and the vary small area to work in, the backfill costs seem to be low.	**A** – We will review these costs.		
10.	Alt 5 Estimate Page 1	Because of the small quantities of AC and site conditions the AC price seem to be low. Quantities are larger than demolish quantities?	**A** – It is. This was an error discovered in our check process. The cost will be adjusted up considerably. We will review the quantities. Note that the overall value of this item is very low in any case.		
11.	Alt 5 Estimate Page 1	The two types sluice gates costs seem to be just material costs therefore seem this costs is low. Are the gate operators and attachment costs included in this price too?	**A** – We costs for the gates are an adjusted cost. A 20% factor has been added to account for installation.		
12.	Alt 5 Estimate Page 1	How do you do the demolish the 96" hole in the concrete and install the pumps? Where is this extra costs in your estimated? Estimate seems to be lacking information in this part.	**A** – The concrete demolition is on the first page of the estimate about 1/3 of the way down (cost = $144,144). The method for demolishing the concrete is described in Section 4.8.2.4.b. The pump installation cost is added to the equipment cost for the pumps (a 10% additional cost on top of the pump costs). This is described in calculation CE-01-0502.		
13.					
14.	Alt1 Estimate Page 1 Forbay Str.	Forbay Intake Structure. Costs seem to be fabricated cost and no installation of metal costs. Where is the cost to ship and install these fabricated item and attach it the underwater bolts? More diving time required? Is a floating plant and mob & demob costs need to be included.	**A** – We will review the cost estimate to assess the installation costs. The intent was for the unit costs for the steel to include installation.		
15.	Alt1 Estimate Page 1 Forbay Str.	Flow chamber skin plate unit costs seem to be material supply costs and not fabricated costs.	**A** – A 50% fabrication surcharge was added to the material costs for the plate steel to account for fabrication. (See calculation CE-01-0502).		

Review Comments Project: Emergency Auxiliary Water Supply **Location:** Little Goose & Lower Granite Dam

XX NPW-EN-DB-CB __ Air Force __ Army		**Design Document** / **Discipline** __ D. Memo __ Concept __ Arch. __ P&S ___ Prlim. __ Civil __ CDR 90% Final __ Mech/Elect. x Costs __ Struct.	**REVIEW CONFERENCE** **A-comment accepted** **W-comment withdrawn** **(if neither, explain)**	**DESIGN OFFICE** **C-correction made** **(if not, explain)**	Back Check By: (Initials)
Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**				**Page 3 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
16.	Alt1 Estimate Page 1 Forbay Str.	Base on past prices the screen assembly costs seem to be low.	**A** – The word "Assembly" here means the completed screen structure assembly, not assembling the screen. The installation of the screen would involve offloading the screen from a truck, lifting it up with a crane, and bolting it in place. A 20% surcharge was added to the quoted price for the screens to account for installation. (See calculation CE-01-0502).		
17.	Alt1 Estimate Page 1 Forbay Str.	Where is the underwater 90"dia tee costs, installation and pipe connection included?	**A** – It is included in Item 2, Water Transport Structures under the section entitled "Water Line Through Dam". The pipe costs were surcharged by 20% to address installation. See calculation CE-01-0502).		
18.	Alt1 Estimate Page 1 Forbay Str.	Where is the spray bar, spray bar pump and spray bar piping costs under water installation and connect costs included?	**A** – The spray system is included in the cost of the screen.		
19.	Alt1 Estimate Page 1 Forbay Str.	Where are the two sluice gates costs in the screen platform?	**A** – They are listed under "Flow Chambers" in Item 1 (cost = $154,692 for 2 gates). Cost includes a surcharge for installation.		
20.	Alt1 Estimate Page 1 Forbay Str.	Where is the adjustable, full head, vertical slot costs included and how is it adjustable? Does this item need to be a sliding gate with operators?	**A** – The "adjustablity" of the vertical slot is not a separate cost item because the vertical slot adjustments come from it being able to be adjusted upon installation and testing and then left in the desired position. No other adjustability is assumed in this design. The costs were rolled into the flow chamber costs.		

Review Comments Project: Emergency Auxiliary Water Supply **Location:** Little Goose & Lower Granite Dam

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Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**				**Page 4 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
21.	Alt1 Estimate Page 1 Forbay Str.	Where are the motor costs and electrical costs that makes the screen rotate (travel)?	**A** – The screens are delivered "ready to plug in". All drive machinery, power, etc. is all ready to go. Only feeder cables for the plant, control panels, etc. are required to bring power to the screens.		
22.	Alt1 Estimate Page 1 & 2 Water Transport Str	Do you have enough diving costs in these items?	**A** – We think so. This will be reviewed.		
23.	Alt1 Estimate Page 1 & 2 Water Transport Str	Do you have enough costs for large 90" pipe connections?	**A** – We think so. This will be reviewed.		
24.	Alt1 Estimate Page 1 & 2 Water Transport Str	Excavation, Load and Haul seem to too low. No hauling costs are included.	**A** – At this level of detail, we don't have enough information as to what the specific offsite (or onsite) storage or dumping options would be during construction. Note that the overall value of this item is quite low in any case.		
25.	Alt1 Estimate Page 1 & 2 Water Transport Str	Are the costs for disposal of demolition AC Paving is not included in the price? (Seem low due to site location)	**A** – (see comment No. 24)		

Review Comments Project: Emergency Auxiliary Water Supply **Location:** Little Goose & Lower Granite Dam

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Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**				**Page 5 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
26.	Alt1 Estimate Page 1 & 2 Water Transport Str	Concrete thrust block cost seem to low. Only material prices seem to be used here. Is there any anchor bolt into existing concrete required? Any reinforcement steel required? Any concrete forming required? Any metal strapping required?	**A** – We will review the costs. It was assumed to be mass concrete with temperature reinforcement only. Per Means, concrete in place costs vary from the low $100's to the low $300's. This seems to be a candidate for the former. Strapping is not required since blocks would be placed in bearing.		
27.	Alt1 Estimate Page 1 & 2 Water Transport Str	For the small wall and elevated slab, site condition the unit price for concrete is too small. For slabs on grade the unit is ok.	**A** - $300 /cy is from Means and is the high end of in-place concrete work (see calculation CE-01-0502).		
28.	Alt1 Estimate Page 1 & 2 Water Transport Str	Are you missing scaffolding to the elevated slab formwork?	**A** – The unit costs are assumed to cover scaffolding for elevated slabs. This is assumed to be a sufficient level of detail for a Phase II Concept Report.		
29.	Alt1 Estimate Page 1 & 2 Water Transport Str	Because of the small quantities of AC and site conditions the AC price seem to be low. Quantities seem to be the same as the demolish quantities with a new concrete slab included?	**A** – It is too low. We will revise it. We will review the quantities. Note that the overall value of this item is very low in any case.		
30.	Alt1 Estimate Page 2 Pump Chamber	Concrete prices seem to low to included forming, material prices and drill new reinforcement into the wall.	**A** – We will adjust the estimate to cover small pours. The cost will be increased to $600 / cy.		

Rev[illegible] Comments Project: Emergency Auxiliary Wate[illegible]pply Location: Little Goose & Lower Granite Da[illegible]

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Date:	**9/18/00 Reviewer: Karl Pankaskie Telephone: 509-527-7517**				**Page 6 of 6**
Item No.	Drawing Sht. Spec. Para.	**COMMENTS**	Action taken on Comments by:		
31.	Alt1 Estimate Page 2 Pump Chamber	Where are the costs to dewater structure?	**A** – Since construction would be conducted during normal maintenance of the ladder, this cost is assumed to be covered in the operations budget of the plant.		
32.	Alt1 Estimate Page 2 Pump Chamber	Where is to costs to drill and install anchor bolts for pipe structures?	**A** – This will be included.		
33.	Alt1 Estimate Page 2 Pump Chamber	Where is pipe flanges installation & costs?	**A** – These were rolled up in the pipe costs (see estimate from Northwest Pipe Company in calculation CE-01-0502).		
34.	Alt1 Estimate Page 2 Pump Chamber	With a concrete ceiling how does the pipes get lifted into places. Where is the lift device or scaffolding access costs?	**A** – The pipe costs were surcharged by 20% to address installation. See calculation CE-01-0502).		
35.					

APPENDIX C

Construction Cost Estimates – Little Goose

PROJECT: LITTLE GOOSE / LOWER GRANITE EMERGENCY AUXILIARY WATER SUPPLY (EAWS) - PHASE II TECHNICAL REPORT
DESIGN STATUS: CONCEPTUAL

DATE: Aug-00
ESTIMATOR: ASB
CHECKED BY: RGW

LITTLE GOOSE ALTERNATIVE 1 - GRAVITY FEED THROUGH NON-OVERFLOW SECTION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**FOREBAY INTAKE STRUCTURE**				
	Flow Chambers				
	Flow Chamber Skin Plate	80,000	LBS	0.80	**63,600**
	Flow Chamber Stiffeners	20,000	LBS	2.9	**58,000**
	Steel Structure Coating	12,000	SF	2.13	**25,560**
	Flow Chamber Anchor Bolt Drill Hole (2")	48	LF	109	**5,232**
	Flow Chamber Anchor Bolt Installation	48	EA	514	**24,672**
	90" Sluice Gate Assembly and Actuator	2	EA	77,346	**154,692**
	Traveling Screens				
	12' Wide Dual-Flow Traveling Screen Assembly	2	EA	240,000	**480,000**
	Screen Debris Return Piping and Supports	1	LS	10,000	**10,000**
	Screen Platform				
	Platform Steel Framing and Bracing	55,000	LBS	2.25	**123,750**
	Platform Anchor Bolt Drill Hole (2")	320	LF	109	**34,880**
	Platform Anchor Bolt Installation	74	EA	514	**38,036**
	Platform Grating (38.5' x 29.5')	1,136	SF	27.3	**30,956**
	Handrail	98	LF	27.7	**2,716**
	Trashrack Guides	9,000	LBS	2.3	**20,250**
	Trashrack Panels	145,000	LBS	2.9	**420,500**
	Screen Platform Access Ladders (Over Parapet Wall)	550	LBS	2.9	**1,595**
	ITEM SUBTOTAL				**1,494,439**
2	**WATER TRANSPORT STRUCTURES**				
	Metal Dewatering Bulkhead				
	Dewatering Bulkhead at Forebay Side of Dam	40,000	LBS	2.9	**116,000**
	Bulkhead Drill Hole (2")	43	LF	109	**4,687**
	Bulkhead Anchor Bolt Installation	16	EA	514	**8,224**
	Bulkhead Metal Removal	1	EA	17,777	**17,777**
	Water Line Through Dam				
	Concrete Demolition (Drill 96" Dia. Hole Through Dam)	45	LF	5,290	**238,050**
	Offsite Disposal of Concrete Materials	84	CY	11	**929**
	Grout 90" Pipe in Hole	12	CY	491	**5,892**
	90" Water Supply Pipe Through Dam Including Tee Section in Forebay	65	LF	780	**50,700**
	Water Line On Dry Side of Dam				
	Excavation for Pipe and Valve Pit	2,830	CY	10.9	**30,904**
	Site Dewatering (Pipe Trench and Valve Pit Excavation)	1	LS	50,000	**50,000**
	Demolition of Buried Temporary Ladder	67	CY	84	**5,628**
	Demolition AC Paving	424	SY	2.91	**1,234**
	Remove and Reinstall Concrete Vault at 48" Juvenile Dewatering Structure Excess Flow Line	1	LS	10,000	**10,000**

LITTLE GOOSE ALTERNATIVE 1 - GRAVITY FEED THROUGH NON-OVERFLOW SECTION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	Offsite Disposal of Concrete and AC Materials	102	CY	11	**1,135**
	90" Water Supply Pipe To Pump Chamber Wall	200	LF	780	**156,000**
	Flexible Pipe Couplings (90")	4	EA	1,500	**6,000**
	Concrete Thrust Blocks (Buried) (At 3 Elbows on 90" Pipe)	75	CY	100	**7,500**
	Reinforced Concrete Vault at Sleeve Valve	95	CY	300	**28,500**
	72" Axial Flow Sleeve Valve at New Vault	1	EA	352,000	**352,000**
	Combination Air/Vacuum Release Valve	2	EA	6,250	**12,500**
	Structure Backfill and Compaction (Using Excavated Material)	2,320	CY	5.69	**13,189**
	Restore AC Paving (3")	3,814	SF	1.36	**5,187**
	Pipe Supports at Sleeve Valve	1,600	LBS	2.9	**4,640**
	5'x5' Access Platform at Air Valve at Dam Face (2 Places)	50	SF	235	**11,750**
	Access Platform Stairs (26 Risers)	1	EA	3,406	**3,406**
	Metal Ladder (27 Vertical Feet With Cage)	1	EA	2,025	**2,025**
	Electrical				
	480 Main Circuit Breaker	1	EA	4,750	**4,750**
	480-Volt Power Conductor	1,600	LF	4.56	**7,296**
	Power Conduit	250	LF	7.50	**1,875**
	480-Volt Power Distribution Center	1	EA	2,400	**2,400**
	7.5 KVA, 120-Volt Load Center	1	EA	550	**550**
	Low Voltage Conduit	200	LF	3.50	**700**
	Low Voltage Conductor	1,200	LF	1.57	**1,884**
	Lighting	12	EA	225	**2,700**
	Control and Monitoring	1	EA	2,750	**2,750**
	ITEM SUBTOTAL				**1,168,762**
3	**PUMP CHAMBER IMPROVEMENTS**				
	Concrete Demolition (9.5' Sq.Hole Through 7' Thick South Wall)	632	CF	105	**66,334**
	Offsite Disposal of Concrete Materials	23	CY	11	**259**
	Concrete Around Pipe at Pipe Penetration in South Wall	10	CY	600	**6,000**
	90" Water Supply Pipe at Pump Chamber (Diffuser Pipe)	79	LF	780	**61,620**
	Pipe Holes ain Diffuser Pipe	1	LS	9,600	**9,600**
	Ring Girders at Pipe	5	EA	7,214	**36,070**
	Pipe Support Anchor Bolt Drill Hole (2") (40 Holes Total)	40	LF	109	**4,360**
	Pipe Support Anchor Bolt Installation	40	EA	514	**20,560**
	Pipe Supports	3,000	LBS	2.9	**8,700**
	ITEM SUBTOTAL				**213,503**
	Subtotal Direct Construction Costs				**2,876,703**

PROJECT: LITTLE GOOSE / LOWER GRANITE EMERGENCY AUXILIARY WATER SUPPLY (EAWS) - PHASE II TECHNICAL REPORT
DESIGN STATUS: CONCEPTUAL

DATE: Aug-00
ESTIMATOR: ASB
CHECKED BY: RGW

LITTLE GOOSE ALTERNATIVE 1 - GRAVITY FEED THROUGH NON-OVERFLOW SECTION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	2,876,703	$	5.0%	**143,835**
	General Contractors Overhead and Profit	3,020,539	$	26.5%	**800,443**
	CONSTRUCTION SUBTOTAL				**3,820,981**
	Construction Contingency	3,820,981	$	25.0%	**955,245**
	TOTAL CONSTRUCTION COSTS				***4,776,227***
	PLANNING AND ENGINEERING	4,776,227	$	22.5%	**1,074,651**
	CONSTRUCTION MANAGEMENT	4,776,227	$	12.5%	**597,028**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$6,447,906**

LITTLE GOOSE ALTERNATIVE 2 - TAILRACE PUMP STATION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**PUMP STATION**				
	Pump Station Lower Structure				
	Pump Chamber Steel Structure Framing and Bracing	295,000	LBS	2.25	**663,750**
	Steel Plate	232,000	LBS	0.80	**184,440**
	Pump Chamber Wall Anchor Bolt Drill Hole (2")	132	LF	109	**14,388**
	Pump Chamber Wall Anchor Bolt Installation	88	EA	514	**45,232**
	Steel Structure Coating	30,000	SF	2.13	**63,900**
	Pump Station Platforms and Screen Guides				
	Platform Steel Structure Framing and Bracing	56,000	LBS	2.25	**126,000**
	Platform Anchor Bolt Drill Hole (2")	108	LF	109	**11,772**
	Platform Anchor Bolt Installation	40	EA	514	**20,560**
	Handrail	131	LF	27.7	**3,630**
	Platform Grating	1,000	SF	27.3	**27,250**
	Fish Screen Guides	108,000	LBS	2.3	**243,000**
	Fish Screening Equipment				
	Fish Screen Panels	2,575	SF	148	**381,100**
	Fish Cleaning Systems	8	EA	20,000	**160,000**
	Pumping Equipment				
	100,000 GPM Line-Shaft Axial Flow Pump (Including Motor, Gear Drive, Discharge Pipe and Flap Gates)	4	EA	642,015	**2,568,060**
	Metal Dewatering Bulkhead (For Concrete Openings in North Shore Fishwater Conduit)				
	Dewatering Bulkhead at Tailrace Side of North Shore Fishwater Conduit (2 Total)	60,000	LBS	2.9	**174,000**
	Bulkhead Drill Hole (2")	24	LF	109	**2,616**
	Bulkhead Anchor Bolt Installation	20	EA	514	**10,280**
	Bulkhead Metal Removal	2	EA	17,777	**35,554**
	Bulkhead Gates				
	Concrete Demolition (12' x 8' Holes Through 3' Thick Wall - 2 Places) (Dry)	576	CF	105	**60,480**
	Offsite Disposal of Concrete Materials	22	CY	11	**244**
	Bulkhead Gate Steel	27,500	LBS	2.9	**79,750**
	Gate Guides	16,500	LBS	2.9	**47,850**
	Gate Guide Anchor Bolt Drill Hole (2")	24	LF	109	**2,616**
	Gate Guide Anchor Bolt Installation	20	EA	514	**10,280**
	Gate Hoist Cable Assemblies (2 Total)	2	LS	1,000	**2,000**
	Dogging Brackets for Gate Hoist System (2 Total)	2	LS	1,000	**2,000**
	Ballasted Removable Steel Slot Plug (2 Total)	20,000	LBS	2.9	**58,000**

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CHECKED BY: RGW

LITTLE GOOSE ALTERNATIVE 2 - TAILRACE PUMP STATION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	Control Gates at Diffuser No. 12				
	Concrete Demolition (Enlarge Existing 3' Square Gate Openings to 3' x 4' - 2 Places)	10	CF	105	**1,050**
	Modify Existing Wall Thimble	2	EA	5,000	**10,000**
	Grout Behind New Wall Thimble Modifications	2	CY	491	**982**
	48" x 36" Sluice Gate w/ AWWA Nut	2	EA	18,780	**37,560**
	Electrical				
	5000-Volt Main Circuit Breaker	2	EA	35,750	**71,500**
	5000-Volt Power Conductor	1600	LF	12	**19,200**
	5000-Volt Motor Control Center	4	EA	19,526	**78,104**
	Cable Tray	200	LF	15	**3,000**
	High Voltage Conduit	200	LF	8	**1,600**
	480-Volt, 40-KVA Power Distribution Center	1	EA	3,850	**3,850**
	480-Volt Power Conductor	100	LF	4.56	**456**
	480-Volt Power Conduit	100	LF	7.50	**750**
	20 KVA, 120-Volt Load Center	1	EA	1,250	**1,250**
	Low Voltage Conduit	200	LF	3.5	**700**
	Low Voltage Conductor	800	LF	1.57	**1,256**
	Lighting	4	EA	225	**900**
	Control and Monitoring	1	EA	6,500	**6,500**
	Boring and Trenching	1	EA	3,450	**3,450**
	ITEM SUBTOTAL				**5,240,860**
	Subtotal Direct Construction Costs				**5,240,860**
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	5,240,860	$	5.0%	**262,043**
	General Contractors Overhead and Profit	5,502,903	$	26.5%	**1,458,269**
	CONSTRUCTION SUBTOTAL				**6,961,172**
	Construction Contingency	6,961,172	$	25.0%	**1,740,293**
	TOTAL CONSTRUCTION COSTS				***8,701,465***
	PLANNING AND ENGINEERING	8,701,465	$	22.5%	**1,957,830**
	CONSTRUCTION MANAGEMENT	8,701,465	$	12.5%	**1,087,683**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$11,746,978**

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LITTLE GOOSE ALTERNATIVE 3 - AWS PUMP REPLACEMENT

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**INSTALL FIRST PUMP**				
	Demolition at AWS Pump Room (Erection Bay) - First Pump				
	Remove Speed Reducer	1	EA	15,000	**15,000**
	Remove Turbine	1	EA	21,000	**21,000**
	Remove Pump	1	EA	21,000	**21,000**
	Remove Discharge/Penstock Piping	1	EA	10,000	**10,000**
	Demo Miscellaneous	1	EA	7,200	**7,200**
	Demo 2nd Stage Concrete	318	CY	750	**238,500**
	ITEM SUBTOTAL				**312,700**
	Equipment Installation at AWS Pump Room - First Pump				
	1275 cfs Propeller Pump	1	EA	1,100,055	**1,100,055**
	1100hp Speed Reducer	1	EA	300,000	**300,000**
	1100hp, 1200rpm Motor	1	EA	52,560	**52,560**
	Prefab & Install Formwork	1376	SF	15	**20,640**
	Second Stage Concrete	300	CY	106	**31,800**
	Speed Reducer Support Steel	9500	LBS	2.3	**21,375**
	Flange Penstock/Turbine Discharge Openings	1	EA	3,260	**3,260**
	ITEM SUBTOTAL				**1,529,690**
	INSTALL FIRST PUMP SUBTOTAL				**1,842,390**
2	**INSTALL SECOND PUMP (First Pump Plus 4% Annual Escalation}**				**1,916,086**
3	**INSTALL THIRD PUMP (Second Pump Plus 4% Annual Escalation)**				**1,992,729**
4	**ADDITIONAL PUMP ROOM WORK**				
	HVAC				
	Air Handkling Units	2	EA	11,640	**23,280**
	Ductwork	800	LBS	5	**4,000**
	Raw Water Piping	200	LF	18	**3,600**
	Electrical	2	EA	800	**1,600**
	ITEM SUBTOTAL				**32,480**
	Electrical (At AWS Pump Room Only)				
	5000-Volt Motor Control Center	3	EA	19,526	**58,578**
	5000-Volt Automatic Transfer Switch	1	EA	38,425	**38,425**
	High Voltage Cable	700	LF	8	**5,600**
	Cable Tray	200	LF	15	**3,000**
	High Voltage Conduit	150	LF	8	**1,200**
	480-Volt Power Conduit	400	LF	8	**3,000**
	480-Volt Power Conductor	400	LF	8	**3,000**
	Low Voltage Conduit	250	LF	9	**2,325**
	Low Voltage Conductor	300	LF	4	**1,050**
	Control and Monitoring	1	EA	7,500	**7,500**
	ITEM SUBTOTAL				**123,678**

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LITTLE GOOSE ALTERNATIVE 3 - AWS PUMP REPLACEMENT

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
5	**STATION SERVICE ELECTRICAL UPGRADE**				
	Transformer				
	2500 KVA Station Service Transformer	2	EA	150,000	**300,000**
	13.8-KV Bus Extension	2	EA	96,550	**193,100**
	High Voltage Fuses	6	EA	10,550	**63,300**
	Switchgear				
	5000-Volt Main Circuit Breaker	2	EA	35,750	**71,500**
	5000-Volt Power Conductor	900	LF	12	**10,800**
	Cable Tray	400	LF	15	**6,000**
	ITEM SUBTOTAL				**644,700**
	Subtotal Direct Construction Costs				**6,552,063**
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	6,552,063	$	5.0%	**327,603**
	General Contractors Overhead and Profit	6,879,666	$	26.5%	**1,823,111**
	CONSTRUCTION SUBTOTAL				**8,702,777**
	Construction Contingency	8,702,777	$	25.0%	**2,175,694**
	TOTAL CONSTRUCTION COSTS				***10,878,471***
	PLANNING AND ENGINEERING	10,878,471	$	22.5%	**2,447,656**
	CONSTRUCTION MANAGEMENT	10,878,471	$	12.5%	**1,359,809**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$14,685,936**

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LITTLE GOOSE ALTERNATIVE 4 - ENHANCED MAINTENANCE AND EQUIPMENT RELIABILITY UPGRADES

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**EQUIPMENT RELIABILITY UPGRADES**				
	Mechanical				
	Speed Increaser Oil Heaters	3	EA	4080	**12,240**
	Electrical				
	480-Volt Main Circuit Breaker	1	EA	4750	**4,750**
	480-Volt Power Conductor	1,200	LF	4.6	**5,472**
	480-Volt Automatic Transfer Switch	1	EA	8000	**8,000**
	ITEM SUBTOTAL				**30,462**
	Subtotal Direct Construction Costs				**30,462**
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	30,462	$	5.0%	**1,523**
	General Contractors Overhead and Profit	31,985	$	26.5%	**8,476**
	CONSTRUCTION SUBTOTAL				**40,461**
	Construction Contingency	40,461	$	25.0%	**10,115**
	TOTAL CONSTRUCTION COSTS				***50,576***
	PLANNING AND ENGINEERING	50,576	$	22.5%	**11,380**
	CONSTRUCTION MANAGEMENT	50,576	$	12.5%	**6,322**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$68,278**
2	**ENHANCED SPARE PARTS INVENTORY**				
	Speed Reducer Lub. Oil Pump	1	EA	550	**550**
	Speed Reducer Thrust Brg. Oil Pump	1	EA	590	**590**
	Speed Reducer Oil Flow Switch	1	EA	200	**200**
	Speed Reducer Temperature Transmitter	1	EA	300	**300**
	Speed Reducer Water Flow Switch	1	EA	200	**200**
	Speed Reducer Temperature Relay	1	EA	200	**200**
	Speed Reducer Spiral Bevel Gearset Assembly	1	EA	16,160	**16,160**
	Speed Reducer Low Speed Helical Gearset	1	EA	49,380	**49,380**
	Speed Reducer Low Speed Output Shaft	1	EA	18,130	**18,130**
	Speed Reducer Thrust and Radial Bearings, Set	1	EA	40,100	**40,100**
	Speed Reducer Thrust Bearing Shoes, Set	1	SET	10,400	**10,400**
	Pump Shaft Seal	1	EA	460	**460**
	Pump Bearing Set	1	EA	1,400	**1,400**
	Turbine Wickett Gate Pins	1	EA	(1)	
	Turbine Wicket Gate Bushings	1	EA	(1)	
	Gateshaft Operator Brake Shoes and Springs	1	EA	2,450	**2,450**
	Gateshaft Operator Gearmotor	1	EA	7,500	**7,500**
	Water Solenoid Valve	1	EA	120	**120**
	TOTAL RECOMMENDED SPARE PARTS (IN 2000 DOLLARS)				**$148,140**

(1) Parts Presently Stored At Little Goose

PROJECT: LITTLE GOOSE / LOWER GRANITE EMERGENCY AUXILIARY WATER SUPPLY (EAWS) - PHASE II TECHNICAL REPORT
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LITTLE GOOSE ALTERNATIVE 5 - AWS INTAKE PUMP STATION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**PUMP STATION**				
	Pump Station Excavation / Site Prep				
	Temporary Vehicle Bridge Over Fish Ladder (20' Span)	1	LS	50,000	**50,000**
	Demolition AC Paving	700	SY	2.91	**2,037**
	Excavation for Pump Station	7100	CY	10.9	**77,532**
	Shoring At Fish Ladder Side of Excavation	1550	SF	41.2	**63,860**
	Site Dewatering (Pump Station Excavation)	1	LS	100,000	**100,000**
	Pump Station Structure				
	Drill and Grout Reinforcing for New Structure at Existing Concrete	1	LS	22,000	**22,000**
	Reinforced Concrete Structure (Formed, Placed, and Stripped)	1,015	CY	300	**304,500**
	Miscellaneous Steel at Concrete Deck Hatches	6,000	LBS	2.9	**17,400**
	Concrete Demolition (96" Hole thru 7' Thick Intake Roof for Pumps - 3 Places) (Wet)	1,056	CF	136.5	**144,144**
	Concrete Demolition (5' x 5' Holes Through 4' Thick Wall for Sluice Gates - 4 Places) (Dry)	400	CF	105	**42,000**
	Concrete Demolition (4' x 4' Holes Through 4' Thick Wall for Sluice Gates - 2 Places) (Dry)	128	CF	105	**13,440**
	Offsite Disposal of Concrete and AC Materials	117	CY	11	**1,298**
	Structure Backfill and Compaction (Using Excavated Material)	4,350	CY	5.69	**24,730**
	Restore AC Paving (3")	4,550	SF	1.36	**6,188**
	60" x 60" Sluice Gate w/ AWWA Nut	4	EA	27,204	**108,816**
	48" x 48" Sluice Gate w/ AWWA Nut	2	EA	19,476	**38,952**
	Remove Temporary Vehicle Bridge Over Fish Ladder (20' Span)	1	LS	10,000	**10,000**
	Pumping Equipment				
	92,000 GPM Submersible Axial Flow Pump	1	EA	387,200	**387,200**
	150,000 GPM Submersible Axial Flow Pump	2	EA	662,200	**1,324,400**
	Pump Supports	3	EA	20,000	**60,000**
	Electrical				
	5000-Volt Main Station Service Circuit Breaker	2	EA	35,750	**71,500**
	5000-Volt Power Conductor	1600	LF	12	**19,200**
	5000-Volt Motor Control Center	3	EA	19,526	**58,578**
	Cable Tray	200	LF	15	**3,000**
	High Voltage Conduit	300	LF	8	**2,400**
	480-Volt, 40-KVA Power Distribution Center	1	EA	2,400	**2,400**
	480-Volt Power Conductor	500	LF	4.56	**2,280**
	480-Volt Power Conduit	200	LF	7.50	**1,500**
	20 KVA, 120-Volt Load Center	1	EA	550	**550**
	Low Voltage Conduit	200	LF	3.50	**700**

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LITTLE GOOSE ALTERNATIVE 5 - AWS INTAKE PUMP STATION

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	Low Voltage Conductor	800	LF	1.57	**1,256**
	Lighting	4	EA	225	**900**
	Control and Monitoring	1	EA	6,500	**6,500**
	Boring and Trenching	1	EA	3,450	**3,450**
	ITEM SUBTOTAL				**2,972,710**
	Subtotal Direct Construction Costs				**2,972,710**
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	2,972,710	$	5.0%	**148,636**
	General Contractors Overhead and Profit	3,121,346	$	26.5%	**827,157**
	CONSTRUCTION SUBTOTAL				**3,948,502**
	Construction Contingency	3,948,502	$	25.0%	**987,126**
	TOTAL CONSTRUCTION COSTS				***4,935,628***
	PLANNING AND ENGINEERING	4,935,628	$	22.5%	**1,110,516**
	CONSTRUCTION MANAGEMENT	4,935,628	$	12.5%	**616,954**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$6,663,098**

APPENDIX D

Construction Cost Estimates – Lower Granite

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LOWER GRANITE ALTERNATIVE 1 - ENHANCED MAINTENANCE AND EQUIPMENT RELIABILITY UPGRADES

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**EQUIPMENT RELIABILITY UPGRADES**				
	Mechanical				
	Speed Increaser Oil Heaters	3	EA	4,080	**12,240**
	Electrical				
	Relocate Motor Control Center				
	Move and Assemble Motor Control Centers	3	EA	12,500	**37,500**
	High Voltage Conduit	120	LF	8	**960**
	High Voltage Conductor	500	LF	12	**6,000**
	Low Voltage Conductor	1,200	LF	1.6	**1,884**
	Low Voltage Conduit	120	LF	3.5	**420**
	Cable Tray	150	LF	15	**2,250**
	Automatic Transfer Switch For Pump 1				
	Transfer Switch	1	EA	40,000	**40,000**
	High Voltage Conduit	65	LF	8	**520**
	High Voltage Conductor	1,500	LF	12	**18,000**
	Cable Tray	200	LF	15	**3,000**
	Low Voltage Conductor	750	LF	1.6	**1,178**
	Low Voltage Conduit	90	LF	3.5	**315**
	ITEM SUBTOTAL				**124,267**
	Subtotal Direct Construction Costs				**124,267**
	CONSTRUCTION RELATED COSTS				
	Mobilization/Demobilization	124,267	$	5.0%	**6,213**
	General Contractors Overhead and Profit	130,480	$	26.5%	**34,577**
	CONSTRUCTION SUBTOTAL				**165,057**
	Construction Contingency	165,057	$	25.0%	**41,264**
	TOTAL CONSTRUCTION COSTS				***206,321***
	PLANNING AND ENGINEERING	206,321	$	22.5%	**46,422**
	CONSTRUCTION MANAGEMENT	206,321	$	12.5%	**25,790**
	TOTAL ESTIMATED COST OF CONSTRUCTION (IN 2000 DOLLARS)				**$278,534**
2	**ENHANCED SPARE PARTS INVENTORY**				
	Speed Reducer Lub. Oil Pump (Falk)	1	EA	550	**550**
	Speed Reducer Lub. Oil Pump (Philadelphia)	1	EA	550	**550**
	Speed Reducer Thrust Brg. Oil Pump (Falk)	1	EA	590	**590**
	Speed Reducer Thrust Brg. Oil Pump (Philadelphia)	1	EA	590	**590**

DATE: Aug-00
ESTIMATOR: GBW/DA
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LOWER GRANITE ALTERNATIVE 1 - ENHANCED MAINTENANCE AND EQUIPMENT RELIABILITY UPGRADES

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	Speed Reducer Oil Flow Switch	1	EA	200	**200**
	Speed Reducer Temperature Transmitter	1	EA	300	**300**
	Speed Reducer Water Flow Switch	1	EA	200	**200**
	Speed Reducer Temperature Relay	1	EA	200	**200**
	Speed Reducer Spiral Bevel Gearset Assembly	1	EA	16,160	**16,160**
	Speed Reducer Low Speed Helical Gearset	1	EA	49,380	**49,380**
	Speed Reducer Low Speed Output Shaft	1	EA	18,130	**18,130**
	Speed Reducer Thrust and Radial Bearings, Set	1	EA	40,100	**40,100**
	Speed Reducer Thrust Bearing Shoes, Set	1	SET	10,400	**10,400**
	Pump Shaft Seal	1	EA	460	**460**
	Pump Bearing Set	1	EA	1,400	**1,400**
	Water Solenoid Valve	1	EA	120	**120**
	Formsprag Device (Rebuilt)	1	EA	5,100	**5,100**
	TOTAL RECOMMENDED SPARE PARTS (IN 2000 DOLLARS)				**$144,430**

APPENDIX E

References

References

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14. *Lower Monumental Dam EAWS Modifications, DDR 60% Review*, June 6, 2000
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